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1500 Series

SYNTHESIZED SIGNAL GENERATOR

Document No. 120077-02

SERVICE MANUAL

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June, 1985

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CHAPTER 1

GENERAL INFORMATION

1-1. INTRODUCTION

1-1.1 This service manual is designed to assist the experienced technician in maintaining the Systron Donner Model 1500 Series Synthesized Signal Generator. The manual contains detailed information covering theory of operation, maintenance, replaceable parts, and necessary assembly drawings and schematics.

1-2. DESCRIPTION

1-2.1 The 1500 Series generators are designed to provide for:

- Typical frequency switching times of <10 mS
- Simultaneous sweep of frequency and power
- AM, FM, and PULSE modulation
- Standard IEEE-488 interface
- Self-diagnostic, with fault indication in order of the highest priority and modular replacement
- Multiple level memory with canned test routines
- Constant FM deviation scaling over entire frequency range.

1-2.2 The generator produces fundamental signals from 0.100 MHz to 1499.999990 MHz with 1 Hz resolution. By using a multi-loop synthesis technique (indirect synthesis), signals are doubled from 1500 MHz to 2500 MHz with 2 Hz resolution. Direct synthesis techniques involve the use of mixers as the frequency conversion elements.

1-2.3 AM and FM modulation of RF output is provided by either an internal 10 Hz to 99.99 kHz source or by an external dc to 100 kHz source. Internal and external modulation features may be used simultaneously.

1-2.4 Pulse modulation of RF output is provided using an external source input at the front or rear panel.

1-2.5 The 1500 Series generators incorporate internal and external leveling capabilities with extremely flat response over the full output frequency range (0.100 MHz to 2500 MHz). A precision attenuator on the output provides accurate variable output levels from −140 to +13 dBm (0.024 μV to V rms).

1-2.6 A General Purpose Interface Bus (GPIB) is standard on the Model 1502, providing control and status reporting from a data bus that conforms to IEEE Std-488-1978. Complete operational control, other than ac power, is accomplished over the bus.

1-3. SPECIFICATIONS

1-3.1 The specifications for the 1500 Series Synthesized Signal Generators are listed in table 1-1. Any acceptance test or calibration procedure will use these specifications as a tolerance guide.

1-4. OPTIONS

1-4.1 Table 1-2 lists the standard options available for the 1501/1502 Synthesized Signal Generators.

Table 1-1. Specifications

Frequency	
Range:	
1501	100 kHz to 1500 MHz
1502	100 kHz to 2500 MHz
Resolution:	
1501	1 Hz
1502	2 Hz (1 Hz below 1500 MHz)
Accuracy and Stability:	Same as internal timebase
Frequency Switching Speed:	<10 msec (typ.)
10 MHz Output:	+7 to +13 dBm into 50 Ω (2 V p-p nominal)
External Input:	10 MHz and any submultiple of 10 MHz, not less than 100 kHz

Time Base: Characteristics	Standard	Option 01
Aging Rate after Warm-Up	±1 part in 10^6/year.	±5 parts in 10^{-10}/24 hours after 72 hours
Frequency Retrace after 24 Hours Off Period	±5 parts in 10^8 within 5 minutes.	1 hour typical to reach ±5 parts in 10^9
Short-Term Stability	±5 parts in 10^{10}/day average for 1 second	±5 parts is 10^{11} RMS for 10 second average
Temperature Variation	TCXO. 1 part in 10^6 over 0 to 70°C	<±2 parts in 10^{10}/°C ±4 parts in 10^9 over a 20°C change within the range of 0°C to +60°C
±10% Change in Line Voltage	±5 parts in 10^8	±5 parts in 10^{10}
Long-Term Aging Rate	±3 parts in 10^7 for 30 days	±1.5 parts in 10^8 for 30 days

RF Output (into 50 Ω)	
Level Range (into 50 Ω):	From maximum available power (not less than +13 dBm) to −140 dBm
Resolution:	0.1 dB
Absolute Level Accuracy:	<±1 dB to >−120 dBm <±3 dB to >−127 dBm

Table 1-1. Specifications — Continued

Level Flatness:	<±1 dB to >−120 dBm <±3 dB to >−127 dBm	
VSWR:	Output	
	< −3 dBm	>−3 dBm
<1 GHz	< 1.5:1	< 2:1
>1 GHz	<2:1	<2:1
Reverse Power Protection:	50 W <1.5 GHz 25 W >1.5 GHz	
Spectral Purity		
Harmonics:	<−25 dBc for power levels ≤+7 dBm	
Non-harmonic:	<−60 dBc <1.5 GHz <−54 dBc >1.5 GHz	
Sub-harmonic:	None to 1.5 GHz <−60 dBc to 2.5 GHz	
Line Related:	<−45 dBc to	<1.5 GHz
	<−39 dBc to	≥1.5 GHz
Residual FM (0.3 to 3 kHz post det. BW):	<5 Hz rms to 1.5 GHz <10 Hz rms to 2.5 GHz	
Residual AM (0.3 to 3 kHz post det. BW):	<−70 dBc	
Typical SSB Phase Noise (20 kHz offset):	<−115 dBc/Hz at 1 GHz	
Digital Sweep		
Start/Stop:		
Frequency	Any within frequency range	
Level	Any within level range	
Step Size:		
Frequency	1 Hz to maximum frequency range of unit	
Level	0.1 dB to maximum level range of unit	
Step Rate:	10 ms to 999 ms.	
Sweep Mode:	Single sweep or continuous	
Amplitude Modulation (AM)		
AM Depth:	0 to 99% to +7 dBm 0 to 30% to +10 dBm	
Resolution:	0.1%	

Table 1-1. Specifications — Continued

AM Rate:	
Internal	20 Hz to 99.9 kHz
External	DC or AC coupled
3 dB Bandwidth:	100 kHz at +7 dBm, depth <90%
AM Distortion:	
<2%, 0 to 30% AM	at 1 kHz
<4%, 31 to 70% AM	rate, +7 dBm
<6%, 71 to 90% AM	output level
AM Depth Accuracy:	6% of setting, depth <90%, rate 1 kHz, level +7 dBm
Incidental Phase Mod (at 30% AM) and 1 kHz rate:	<0.3 radians peak
External Input:	
Sensitivity	100%/V (1V pk= 100% AM)
Absolute maximum input	±10 V
Frequency Modulation (FM)	
Peak Deviation:	
Internal	999 kHz
External	1 MHz
Deviation Resolution (Internal):	10 Hz for deviation <10 kHz 100 Hz for deviation <100 kHz 1 kHz for deviation <1 MHz
FM Rate:	
Internal	20 Hz to 99.9 kHz
External	DC to 100 kHz (3 dB)
FM Distortion (1 kHz rate):	<2% for deviations >25 kHz <1% for deviations >50 kHz
FM Deviation Accuracy:	±7% of setting
Incidental AM (1 kHz rate, 20 kHz deviation) $f_o > 1$ MHz:	<0.3% pk
External Input:	
Sensitivity:	10 kHz/V, 100 kHz/V or 1 MHz/V
Absolute maximum input:	±10 V
Pulse Modulation: ($F_o \geq 10$ MHz)*	
Rise/Fall Time:	<100 ns
Minimum Pulse Width:	6 μs

Table 1-1. Specifications — Continued

On/Off Ratio:	>60 dB
Repetition Rate:	10 Hz to 100 kHz
External Input:	
Impedance:	50 Ω nominal, dc coupled
Input level:	TTL compatible, 1.5 V threshold
Absolute maximum input:	±10 V
General	
Memory Store/Recall:	10 registers in non-volatile memory that save all front panel settings
Remote Programming Interface:	IEEE-488 1978. Interface functions implemented: SH1, AH1, L4, LE0, T6, TE0, SR1, RL1, PP0, DC1, DT0, C0
Operating Temperature:	0 to 50°C
Power Requirements:	100, 120, 220, or 240 V (+5%, −10%); 48 to 440 Hz; 125 VA maximum
Weight:	<60 lbs
Size:	5.25 H × 16.75 W × 20.5 D (in inches)

*Pulse output available below 10 MHz but not specified.

Table 1-2. Standard Options

Option	Description
01	High stability timebase oscillator rated at $\pm 5 \times 10^{-10}$/day.
02	Provide a rear panel RF output connector in lieu of the standard front panel configuration.
03	Rack mount kit w/slides.

CHAPTER 2

PRINCIPLES OF OPERATION

2-1. INTRODUCTION

2-1.1 This chapter will provide a general understanding of the methods used to produce the 1500 Series instrument's output signal. The method used will consist of two sections; first a block diagram analysis to describe the overall functional operation, then a detailed circuit description of each printed circuit (PC) assembly.

2-1.2 The 1500 Series generators produce a radio frequency (RF) output from 100 kHz to 2500 MHz, with a 1 Hz resolution for frequencies between 100 kHz and 1500 MHz (Model 1501) and 2-Hz resolution for frequencies above 1500 MHz (Model 1502). The amplitude of this RF signal is closely controlled, and the signal can be amplitude modulated, frequency modulated, and pulse modulated. Simultaneous amplitude and frequency modulation is possible, as is simultaneous frequency and pulse modification, but simultaneous amplitude and pulse modulation can not be performed.

2-2. BLOCK DIAGRAM DESCRIPTION

2-2.1 The frequency synthesis scheme used in the 1500 Series instruments is based on the "multi-loop" approach due to the need to produce stable, accurate RF signals with 1 Hz or 2 Hz resolution and low spurious response. An instrument contains ten (10) phase-locked loops, a closed loop level control system, two programmable audio sources, and two microprocessor systems. When following the discussion, refer to the functional block diagram figure 5-1 as an aid in understanding instrument operation.

2-3. SYSTEM CONTROLS

2-3.1 The instrument contains two separate microprocessor systems. Maintenance of the instrument's front panel and data displays, control and interpretation of keyboard inputs, and determination of frequency and level sweep parameters, are performed by the Front Panel Interface PC Assembly A2. Command and control functions within the instrument are performed by the CPU PC Assembly A15.

2-3.2 Common to most of the instrument's circuit boards, the system communication bus permits CPU PC Assembly A15 to issue instructions to circuits which control the RF output frequency and level, determine the instrument's operating modes, and generate internal modulation frequencies. This bus is bidirectional, permitting determination of the status of the various signal-producing and controlling circuits.

2-3.3 In the event of a malfunction within the instrument, or the application of an RF, AM, or FM signal of excessive amplitude, the front panel modulation display will show an error code. These codes are intended to alert the operator to a possible failure and serve as an initial guide toward corrective action. Refer to Chapter 3 of this manual for more information on these codes.

2-4. FREQUENCY SYNTHESIS

2-4.1 The frequency synthesis scheme used in the 1500 Series will be discussed by considering its control loops individually, regardless of their location, rather than taking each circuit board as a discrete element. Control circuits have been separated into digital and analog sections to minimize the digital noise that might be applied to the instrument's RF output.

2-4.2 Reference Oscillator. The instrument's output frequency is derived from the frequency of a 10-MHz crystal oscillator on 10-MHz Reference PC Assembly A18. The accuracy and stability of the RF output thus depends on the characteristics of this oscillator. For those situations where long term accuracy is important a high stability oscillator (Option 01) may be used in place of the standard 10-MHz oscillator. In addition, the unit may be locked to an external timebase signal; the frequency of this external signal may be 1, 2, 2.5, 5, or 10 MHz. Signal switching between internal and external oscillators is accomplished on the Reference Frequency Generator PC Assembly A14.

2-4.3 Reference Frequencies. The 10-MHz reference signal, whether from the internal (A18 PC Assembly) or an external oscillator, is applied to the Reference

Frequency Generator PC Assembly, A14. This signal is used to phase lock the 100-MHz main reference frequency. This 100-MHz signal is used as a reference frequency by the A6 PC Assembly and is divided to create several additional frequencies which are used throughout the instrument as references for the various phase-locked loops.

2-5. LOOP 1

2-5.1 Loop 1 on PC Assemblies A7 and A8 is the primary source of the instrument's RF output signal. This phase-locked loop produces the instrument's output signal directly for frequencies from 250 to 1500 MHz, and indirectly for signals below 250 MHz or above 1500 MHz.

2-5.2 Frequencies From 250 to 1500 MHz. For frequencies in this range, the output is directly derived from a trio of oscillators on Loop 1 PC Assembly A7. These oscillators operate from 250 to 499.999,999 MHz, 500 to 999.999,999 MHz and 1000 to 1499.999,999 MHz. Circuitry on Loop 1 PC Assembly determines which of these oscillators is used, depending on the desired output frequency.

2-5.3 Frequencies Below 250 MHz. Loop 1 produces an 800.1 to 1050-MHz signal that is mixed with a fixed 800 MHz signal to produce the desired output frequency; the Loop 1 oscillators operate at a frequency 800 MHz higher than the desired output frequency. Creation of the 800-MHz signal and the mixing process are performed by Loop 8, on Downconverter PC Assembly A6.

2-5.4 Frequencies Above 1500 MHz. Loop 1 produces a 750 to 1250 MHz signal which is directed through Output Module Section 1 Assembly A23, to Output Module Section 2 Assembly A22, where the signal frequency is doubled to produce frequencies from 1500 to 2500 MHz.

2-5.5 Output Frequency Selection. Selection of the final output signal is performed by Output Module Section 1 A23 PC Assembly. The selection function is controlled by the A15 PC Assembly through circuits on the Interface PC Assembly A3.

2-5.6 Phase Lock Process Loop 1. Four separate signals are required to control the frequency of the Loop 1 oscillators. These are: (1) the output of the oscillator itself; (2) a 272 to 544 MHz signal from loop 2; (3) either a 100-MHz frequency modulated signal created on Loop 9, or a fixed 100-MHz signal from the Reference Frequency Generator A14 either of which is divided by 2 to produce a 50-MHz signal: and (4) a 5 to 8-MHz signal which is generated by dividing the Loop 5 output by 50 on the Divide-by-Q PC Assembly A12.

2-5.7 First Conversion Process. The 272 to 544 MHz signal from Loop 2 is multiplied on Loop 1 IF PC Assembly A8, by a factor H whose value may be 1, 2, or 3. The choice of multiplication is determined by whether the 250-500 MHz, 500-1000 MHz or 1000-1500 MHz Loop 1 oscillator, respectively, is in use. The signal from Loop 2 has 1-MHz resolution, and the multiplied signal moves in 1-, 2-, or 3-MHz increments depending on the multiplication factor. The multiplied signal is mixed with the signal from Loop 1 to produce an IF output of 42 to 45 MHz.

2-5.8 Second Conversion Process. The 42 to 45 MHz IF output from the first conversion is now mixed again, this time with a 50-MHz signal derived either from the oscillator in Loop 9, or from the Reference Frequency Generator PC Assembly A14; source selection is performed on the A9 PC Assembly. This second mixer is also located on Loop 1 IF PC Assembly A8. (Note: This is the injection point for frequency modulation.)

2-5.9 Phase Detection. The result of the second mixing process is a 5- to 8-MHz signal which is compared by a phase detector on the Loop 1 PC Assembly A7, to a similar frequency derived from Loop 5. The Loop 5 signal, after division by 50 on the Divide-by-Q PC Assembly A12, has 1-Hz resolution and moves from 5 to 6, 5 to 7, or 5 to 8 MHz, depending on the multiplication factor H applied to the signal from Loop 2. The output of the phase detector controls the frequency of the Loop 1 oscillator.

2-5.10 Loop 1 Coarse Tune. A coarse tune voltage, created on the Loop 1 IF PC Assembly A8, pre-tunes the Loop 1 oscillator to approximately the correct frequency. The fine tune necessary to put the output oscillator at the exact output frequency required is provided by the phase-lock circuitry.

2-6. LOOP 2

2-6.1 The signal generated by Loop 2, on Loops 2 and 9 PC Assembly A9, provides the high frequency reference signal used to lock the output loop, Loop 1. The Loop 2 output covers the range 272 to 544 MHz in 1-MHz steps by summing the output frequencies of Loop 3, covering the range 240 to 500 MHz in

20-MHz steps, and Loop 4, which covers the range 25 to 44 MHz in 1-MHz steps.

2-6.2 The Phase Lock Process Loop 2. The Loop 3 output is mixed with the 272- to 544-MHz output from Loop 2, producing an IF of 25 to 44 MHz. This signal is compared by a phase detector with the 25- to 44-MHz signal from Loop 4; this signal moves in 1-MHz increments. The output of the phase detector controls the frequency of the Loop 2 oscillator.

2-6.3 Loop 2 Coarse Tune Voltage. A coarse tune voltage, created on the Loop 1 IF PC Assembly A8, pre-tunes the Loop 2 oscillator to approximately the correct frequency. The fine tune necessary to put the Loop 2 oscillator at the exact frequency required is provided by the phase-lock circuitry.

2-7. LOOP 3

2-7.1 Loop 3, on Loops 3 and 4 PC Assembly A10, covers the range 240 to 500 MHz and controls the frequency of the Loop 2 oscillator in 20-MHz steps.

2-7.2 Phase Lock Process Loop 3. A 20-MHz reference signal from the Reference Frequency Generator PC Assembly A14 is effectively multiplied by an impulse generator circuit (xM) which produces an impulse signal at a 20-MHz repetition rate. The Loop 3 oscillator output operates from 240 to 500 MHz. This signal is sampled by the 20-MHz impulse signal using a sampling bridge phase detector. The dc output signal from the phase detector controls the frequency of the Loop 3 oscillator.

2-7.3 Loop 3 Coarse Tune Voltage. The impulse generator produces multiple harmonics of 20 MHz. A coarse tune voltage pre-tunes the Loop 3 oscillator to a frequency near that of the correct harmonic to prevent phase-lock to the wrong 20-MHz harmonic.

2-8. LOOP 4

2-8.1 Loop 4, on A10 and A11, controls the frequency of the Loop 2 oscillator in 1-MHz steps.

2-8.2 Phase Lock Process Loop 4. The Loop 4 oscillator produces an output from 250 to 440 MHz. A portion of this signal is sent to a programmable Divide-by-N circuit, which divides the oscillator frequency by an integer between 25 and 44 to produce a 10-MHz output. The divider output is compared by a phase detector with a 10-MHz reference from A14. The phase detector output controls the frequency of the Loop 4 oscillator. Since the reference frequency to the phase detector is 10 MHz, the output of the Loop 4 oscillator moves in 10-MHz steps.

2-8.3 Divide-by-10. The 250 to 440-MHz output of Loop 4 is divided by 10 to produce a 25 to 44-MHz signal which moves in 1-MHz steps. This latter signal is used to control the Loop 2 oscillator.

2-9. LOOP 5

2-9.1 Loop 5 on A13, provides the Loop 1 oscillators with 1-Hz frequency resolution.

2-9.2 Phase Lock Process Loop 5. The Loop 5 oscillator produces an output frequency of 250 to 399.999,950 MHz which moves in 50-Hz steps. The output of Loop 6 moves from 249.6 to 399.2 MHz in 400-kHz steps. These two signals are mixed together to produce an IF output of 400.00 to 799.95 kHz. This IF signal is compared by a phase detector to a 400 to 799.95-kHz signal from Loop 7. The phase detector controls the Loop 5 oscillator.

2-9.3 Divide-by-50. The 250 to 399.999,950-MHz output from Loop 5 moves in 50-Hz steps. This signal is divided by 50 by circuitry on the Divide-by-Q PC Assembly A12 to produce a 5 to 7.999,999 MHz signal which moves in 1-Hz steps. This latter signal is used to control the frequency of the Loop 1 oscillators.

2-10. LOOP 6

2-10.1 Loop 6, on A11 and A13, is used to control the output frequency of Loop 5 in 400-kHz steps.

2-10.2 Phase Lock Process Loop 6. The Loop 6 oscillator produces an output from 249.6 to 399.2 MHz. A portion of this signal is sent to a programmable Divide-by-P circuit which divides the frequency by an integer between 624 and 998 to produce a 400-kHz output. The divider output is compared by a phase detector on A13 with a 400-kHz reference from the Reference Frequency Generator PC Assembly A14. The phase detector output controls the frequency of the Loop 6 oscillator. Since the reference frequency to the phase detector is 400 kHz, the output of the Loop 6 oscillator moves in 400-kHz steps.

2-11. LOOP 7

2-11.1 Loop 7, on A12 and A13, is used to control the output frequency of Loop 5 in 50 Hz steps.

2-11.2 Phase Lock Process Loop 7. The Loop 7 oscillator produces an output from 40.000 to 79.995 MHz. A portion of this signal is sent to a programmable Divide-by-Q circuit which divides the oscillator frequency by an integer between 8,000 and 15,999 to produce a 5-kHz output. The divider output is compared by a phase detector with a 5-kHz reference from A14. The phase detector output controls the frequency of the Loop 7 oscillator. Since the reference frequency to the phase detector is 5 kHz, the output of the Loop 7 oscillator moves in 5-kHz increments.

2-11.3 Divide-by-100. The 40.000 to 79.995-MHz output from the Loop 7 oscillator is divided by 100 by circuitry on the Divide-by-Q PC Assembly A12, to produce a 400 to 799.95-kHz signal which moves in 50-Hz steps. This signal is applied to Loop 5.

2-12. LOOP 8

2-12.1 Loop 8, on A6, produces a fixed 800-MHz signal which is mixed with an output from Loop 1 to produce the instrument's RF output for frequencies below 250 MHz.

2-12.2 Phase Lock Process Loop 8. The Loop 8 oscillator operates at 800 MHz. A portion of its output is divided by 8 to produce a 100-MHz signal which is compared by a phase detector to a fixed 100-MHz reference generated on A14. The phase detector's output controls the Loop 8 oscillator.

2-12.3 Downconversion. The 800-MHz signal from Loop 8 is mixed with an 800.100,000 to 1049.999,999 MHz signal from Loop 1 to produce a 0.100,000 to 249.999,999-MHz output. This low frequency signal is applied to Output Module Section 1 Assembly A23, and when selected appears at the instrument's RF output connector.

2-13. LOOP 9

2-13.1 Loop 9, on A9, produces a frequency modulated signal which, when selected, provides frequency modulation of the instrument's RF output.

2-13.2 Signal Switching. A solid-state switch on A9, selects between the 100-MHz output of the Loop 9 oscillator and a 100-MHz reference signal from A14. The output of this switch is applied to a Divide-by-2 on A12.

2-13.3 Divide-by-2. The 100-MHz signal from A9 is divided by circuitry on the A12 PC Assembly to produce two 50-MHz signals. One of these signals is applied to the Loop 1 IF PC Assembly A8, where it is used in Loop 1's second conversion process. The other signal is divided by 10,000 to produce a 5-kHz signal which is then returned to Loop 9 on A9.

2-13.4 Frequency Modulation. Audio frequencies from the FM Audio Synthesizer PC Assembly A5A2 and from the external FM input connector are applied to solid-state switches on A9. These switches select internal or external modulating signals, set the FM deviation sensitivity, and apply this scaled modulating signal to the Loop 9 oscillator. The average frequency of this oscillator is held at 100 MHz by the phase-lock circuitry, except in the DCFM mode where the oscillator is free-running at approximately 100 MHz. FM deviation accuracy depends on the linearity of the Loop 9 oscillator.

2-13.5 Phase Lock Process Loop 9. The 5-kHz signal from the Divide-by-10,000 on A12 is compared by a phase detector to a 5-kHz reference on A14. The phase detector output controls the frequency of the Loop 9 oscillator. The Loop 9 oscillator is not phase-locked when DC-couple FM is selected.

2-13.6 Phase Noise. To reduce phase noise when FM modulation is not required, the Loop 9 oscillator is disabled and a 100-MHz signal reference from A14, with its superior noise performance, is used.

2-14. RF OUTPUT CONTROL

2-14.1 For all practical purposes the 1500 Series can be considered as having three separate signal sources; Loop 1, the Downconverter, and the Doubler. Since the instrument only has a single RF output, some provision must be made to select the appropriate signal and apply it to the output. Also, there must be some means to control the power level of the signal and to impose amplitude and pulse modulation upon it.

2-14.2 Signal Selection. The 0.100 to 250-MHz signal from the Downconverter PC Assembly A6, the 250 to 1500-MHz signal generated by the Loop 1 PC Assembly A7, and the 1500 to 2500-MHz signal from Output Module Section 2 A22, are all applied to Output Module Section 1 A23. Solid-state switches select one of these signals, depending on the desired output frequency and, after passing this signal through a level detector module, applies the selected signal to the instrument's step attenuator on A22. The attenuator's output is then applied to the instrument's RF output connector. Signal selection functions are controlled by the CPU PC Assembly A15, through circuits on the Interface PC Assembly A3.

2-14.3 Filtering. Harmonic, subharmonic, and spurious rejection is acheived by filters on A6, A23, and A22. The 0.1 to 250-MHz signal on A6 passes through a lowpass filter to minimize unwanted mixing products. The 250 to 1500-MHz signal generated by Loop 1 is filtered on A23 to minimize unwanted oscillator harmonics. The 1500 to 2500-MHz signal on A22 is filtered to reject unwanted harmonic and subharmonic spurious resulting from doubling.

2-14.4 Level Detection and Control. The RF signal selected by Output Module Section 1 A23, is applied to a detector diode before exiting the assembly. This detector has a reference diode to which RF energy is not applied; this reference diode is used to minimize the effects of temperature on the instrument's RF output level. The voltage difference between the outputs of the detector and reference diodes depends on the RF power level present at the detector diode.

2-14.5 RF Level Calibration. The outputs of the detector and reference diodes are buffered, then applied to the inputs of a differential amplifier, whose output is provided with individually adjusted offset and gain controls. These permit calibration of the instrument's RF output level, as the detector circuit's output can be made to conform to a single, fixed relationship between output voltage and RF power level, regardless of RF frequency. The processed detector output is sent to the Level Control PC Assembly, A4.

2-15. LEVEL CONTROL

2-15.1 Circuitry on the Level Control PC Assembly, A4, generates level control voltage proportional to the desired RF output level, determines the error between this voltage and the processed detector voltage, and generates a control signal which adjusts the instrument's RF level as necessary to maintain the desired output level. When pulse modulation is used, a sample-and-hold circuit stores a voltage proportional to the peak power of the RF pulse when the RF output is pulsed off. This sample-and-hold circuit is only used when pulse modulation is selected.

2-15.2 Levelers. These are RF devices whose attenuation depends on the current passing through them. The 1500 Series uses two such devices, both located on the A22 PC Assembly.

2-16. PULSE MODULATION

2-16.1 A processed version of the pulse signal applied to the pulse input is used to control a PIN diode modulator, located on Output Module Section 2 PC Assembly, A22. The level control circuitry determines the output level when the RF is on. This circuitry is located on the Level Control PC Assembly A4, as is the circuitry that operates the sample-and-hold circuit necessary to control the RF power level when pulse modulation is applied.

2-17. AMPLITUDE MODULATION

2-17.1 An audio signal from the AM Audio Synthesizer PC Assembly A5A1, the external AM input connector, or both, may be used to provide amplitude modulation of the RF output. The modulation is achieved by scaling and summing the modulating signal to the level control voltage.

2-18. FLATNESS COMPENSATION

2-18.1 The CPU PC Assembly A15 uses a data table which describes any variations in the instrument's RF output as a function of frequency and/or step attenuator range. This data is used to adjust the level control voltage to provide a flat RF output with minimum variation in amplitude, regardless of RF frequency or step attenuator range.

2-19. STEP ATTENUATOR

2-19.1 The step attenuator provides 0 to 130 dB attenuation of the RF output in 10-dB steps. The attenuator setting is controlled by the CPU PC Assembly A15, through circuitry on the Interface PC Assembly A3.

2-20. SUPPORTING CIRCUITRY

2-20.1 The preceding paragraphs provide a general understanding of the major circuit functions within the 1500 Series instruments. The remaining circuitry is described below.

2-20.2 Power Supply. The regulated power supply voltages required for instrument operation are created on the Power Supply PC Assembly A16. Circuitry which controls the speed of the instrument's cooling fan is also located here.

2-20.3 Front Panel. As well as permitting manual entry of commands and data, the Keyboard and Display PC Assembly A1 provides visual indications of the instrument's output frequency, RF level, internal amplitude modulation rate and depth, internal frequency modulation rate and deviation, frequency and level sweep start and stop points, sweep rates and sizes, and operating modes. The operation of the Keyboard and Display PC Assembly, A1, is controlled by the Front Panel Interface PC Assembly, A2.

2-20.4 Shaft Encoder. This rotary device provides Edit facility to adjust instrument operating parameters. It provides data for the Front Panel Interface PC Assembly, A2.

2-20.5 Audio Synthesizers. These PC Assemblies (A5A and A5B) provide internal audio sources for amplitude and frequency modulation. Independent control of AM depth, AM rate, FM deviation, and FM rate is available.

2-20.6 IEEE-488 Interface. The circuitry for this function is located on the CPU PC Assembly A15. The IEEE-488 interface permits external computer control of all instrument functions except ac power on or off.

2-20.7 Cooling Fan. This device provides a flow of coolant air for the instrument. Its speed is variable, and depends on the ambient temperature and the internal temperature of the instrument. The cooling fan is controlled by circuitry on the Power Supply PC Assembly A16.

2-20.8 Motherboards. The main motherboard A17 and power distribution motherboard A24, provide power distribution, control distribution, and signal interconnection for the majority of the instrument's PC boards.

2-21. DETAILED CIRCUIT DESCRIPTIONS

2-21.1 Detailed circuit descriptions for the 1500 Series instruments are provided in the following paragraphs. Refer to Chapter 5 of this manual for schematic assembly figures referenced in the circuit analysis that follows.

2-22. KEYBOARD AND DISPLAY A1 AND FRONT PANEL INTERFACE A2 PC ASSEMBLIES

2-22.1 The Keyboard and Display PC Assembly A1 and Front Panel Interface PC Assembly A2 work together to store and to provide the user with information concerning the instrument's RF output frequency and level, internal amplitude modulation depth and rate, internal frequency modulation deviation rate, application of external modulating signals, and RF frequency and level sweep parameters. Because of this intimate interaction, it is necessary to discuss the two assemblies together. Refer to figure 5-12.

2-22.2 Component Location. The A1 PC board mounts the various liquid-crystal displays (LCD's), light-emitting diode (LED) annunciators, and indicators and front panel keyswitches, while the A2 PC board contains a controlling microprocessor and various circuits which interpret user inputs and determine the information presented by the front panel displays. All components mentioned in the discussion below are found on the A2 PC board unless specified otherwise.

2-22.3 Power-On Reset (Figure 5-12 sheet 1 of 8). Timer U7 provides a power-on reset function for the microprocessor and its supporting circuitry. Switch S1 (which is not accessible from the front panel) provides a manual reset capability for troubleshooting purposes.

2-22.4 Keyboard Microprocessor (Sheet 1 of 8). Microprocessor U10 is responsible for controlling the instrument's front panel liquid-crystal displays and LED annunciators and indicators, interpreting keyboard commands, converting data from one format to another (e.g. level display in dBm or mV), communicating with the A15 PC Assembly, and generating new level or frequency data when the instrument is in a sweep mode.

2-22.5 Memory, I/O and Peripheral Device Selection (Sheet 1 of 8). Device selection is controlled by two 1-of-8 decoders. U9 selects NOVRAM and EPROM, and U18 selects shaft encoder, system intercommunication, annunciators and indicators, display, keyboard, and timer.

2-22.6 Non-Volatile Random-Access Memory ($0XXX) (Sheet 1 of 8). U13 provides a "scratchpad" memory for U10 and stores up to 10 complete front panel settings.

2-22.7 Read-Only Memory ($8XXX,CXXX) (Sheet 1 of 8). U14 and U15 are 16 kilobyte programmable devices which store U10's control software.

2-22.8 Shaft Encoder ($40XX) (Sheet 8 of 8). The Shaft Encoder Assembly on the front panel detects rotation of the front panel knob, and produces 2 square wave outputs (Phase A and Phase B). The decoder circuit U60 determines the direction of rotation and clocks counters U61 and U62 to produce an 8-bit code used by U10 to determine the direction and amount of rotation of the knob.

2-22.9 The state of the D7 data line is used to determine whether the knob was turned cw or ccw. If D7 is HIGH, it is assumed that the rotation was ccw and that the count in U61 and U62 decreased from 00 to FF or some lower value, rather than counting up to that value.

2-22.10 The user-selected instrument parameter is incremented or decremented, as appropriate, by the number of counts away from 00. Transceiver U63 permits the data on the counters to appear on the data bus when $\overline{\text{SPW}}$ is LOW, and U64 resets the counters at the end of the $\overline{\text{SPW}}$ pulse.

2-22.11 System Intercommunication ($44XX) (Sheet 2 of 8). Communication between Keyboard and Display A2, and CPU A15 is required to transfer data pertaining to instrument operation and status. This is accomplished by having the microprocessors on A2 and A15 share access to 16 bytes of memory in U43 and U48. Both microprocessors are able to write to, and read from, these devices. Note that data at the outputs of these two devices is the inverse of the data written into them.

2-22.12 Access arbitration and data transfer are accomplished by the methods described below.

2-22.13 Data Transfer from the A2 PC Assembly to the A15 PC Assembly. When the RAM line goes LOW flip-flop U16-5 is reset, thereby terminating any interrupt request ($\overline{\text{IRQ}}$) created by the intercommunication circuit and thus, originating with the A15 PC Assembly. Since U10 is to write data into U43 and U48, the Read/$\overline{\text{Write}}$ line is LOW, U23-11 is LOW and causes U23-9 to be set, placing its $\overline{\text{Q}}$ output HIGH and its Q output LOW. This causes quad multiplexer U46 to pass the RAM address from the keyboard address bus to U43 and U48; causes U20 to pass U10's Read/$\overline{\text{Write}}$ signal through inverter U19-6 to the $\overline{\text{Output}}$ Enable inputs (pins 1 and 19) of inverting buffer U44; and places a HIGH at the Data input of U16-5.

2-22.14 Simultaneously, the $\overline{\text{G}}$ input of buffer U36 is enabled, permitting data from U10 to pass through to the inputs of U43 and U48. When the Enable output goes LOW, indicating valid data, U31-3 is LOW, permitting this data to be written into U43 and U48. Since the Read/$\overline{\text{Write}}$ line is LOW at this time, U44's outputs are in the high-impedance state.

2-22.15 When data is written into address $0F, comparator U45 produces a HIGH at its A=B output. When this HIGH disappears, monostable multivibrator U30-13 is triggered. Flip-flop U23-9 (which is no longer held in the preset state, since either $\overline{\text{RAM}}$ or Read/$\overline{\text{Write}}$ is now high) is clocked by the rising edge at the end of U30-13's $\overline{\text{Q}}$ output pulse and toggles, producing a LOW on its Q output. This LOW appears on the data input of flip-flop U16-5.

2-22.16 The falling edge of the positive going pulse from U30-13's Q output triggers U30-12, and flip-flops U16-5 and U23-5 are clocked by the rising edge of the negative-going pulse at U30-12's $\overline{\text{Q}}$ output. Since U23-9's Q output is now LOW and its $\overline{\text{Q}}$ output is HIGH, U16-5 does not change but U23-5 goes HIGH causing Q2 to generate an interrupt request ($\overline{\text{SIRQ}}$) to the A15 PC Assembly, informing it that there is a communication from the A2 PC board.

2-22.17 Once U10 has written the data into U43 and U48 and $\overline{\text{SIRQ}}$ has taken place, the A15 PC board sets the four high bits, SA4 to SA7, of the system address bus LOW. This is detected by digital comparator U32, which produces a HIGH at its A=B output. This resets U23-5, causing a LOW at its output, terminating any $\overline{\text{SIRQ}}$ from the A2 PC board.

2-22.18 Meanwhile, assuming that U10 is performing some task not involving system intercommunications, its $\overline{\text{RAM}}$ line is HIGH, causing a HIGH at U36 pin 19 and at U31 pin 2. As nothing has happened to cause U23-9 to change its state, its Q output is LOW and its $\overline{\text{Q}}$ output is HIGH. This causes U20 to pass the Read/$\overline{\text{Write}}$ signal from the system data bus, and U46 to pass address information from the system address bus to U43 and U48. Since the CPU PC Assembly, A15, is reading data its Read/$\overline{\text{Write}}$ line is HIGH; U19-6 inverts this to cause a LOW at U44's $\overline{\text{Enable}}$ inputs, and data present in U43 and U48 appears on U44's outputs.

2-22.19 During all this the four high bits of the system address bus remain unchanged; therefore U19 pin 4 is LOW. Since U23-9's Q output is LOW, U22 pin 6 is LOW and transceiver U37 is enabled, permitting the data from U44 to appear on the system data bus, where it can be read by the microprocessor on the A15 PC board.

2-22.20 At the end of this data transfer process, U23-9's Q output is LOW. This allows the A15 PC Assembly to write data into U43 and U48 at the beginning of its data transfer to the A2 PC Assembly.

2-22.21 Data Transfer from the A15 PC Assembly to the A2 PC Assembly. Assuming that U10 is performing some task not involving system intercommunications, its $\overline{\text{RAM}}$ line is HIGH, causing a HIGH at U36 pin 19 and at U31 pin 2.

2-22.22 The A15 PC board sets the four high bits, SA4 to SA7, of the system address bus to zero ($0X). This is detected by digital comparator U32, which produces a HIGH at its A=B output, which in turn is inverted by U19-4 to produce a LOW which resets U23-5, causing a LOW at its output and terminating any $\overline{\text{SIRQ}}$ from the A2 PC board.

2-22.23 When data written by the A15 PC board is valid, the $\overline{\text{DAV}}$ line is LOW and SRead/$\overline{\text{Write}}$ is LOW. This causes a LOW on U22 pin 8 and on U31 pin 3, permitting data transfer into U43 and U48.

2-22.24 Since the CPU PC board is maintaining the four high bits of the system address bus LOW, and is writing to U43 and U48 (placing the SRead/$\overline{\text{Write}}$ line LOW), U19 pin 4 is LOW. If a previous write from U10 has occurred, then U23 pin 9 is also LOW. This causes U22 pin 6 to be LOW, enabling the outputs of transceiver U37. Data on the system data bus now transfers through U37 to the inputs of U43 and U48.

2-22.25 Since, if U23-9's Q output is LOW its $\overline{Q}$ output is HIGH, U20 passes the A15 PC board's SRead/$\overline{\text{Write}}$ signal to U19, which then has a HIGH at its output. This places the outputs of U44 in the high-impedance state.

2-22.26 Now address $0F is written to, triggering monostable multivibrator U30-13. The output pulse from U30-13 triggers U30-12 and toggles flip-flop U23-9, which makes the Q output of U23-9 and the data input of flip-flop U16-5 become HIGH. The output pulse from U30-12 clocks U16-5, generating an $\overline{\text{IRQ}}$ to U10. Next, U10 reads the data in U43 and U48, placing its Read/$\overline{\text{Write}}$ line HIGH, which lets U36 pass data from U44 to the data bus, and placing its $\overline{\text{RAM}}$ line LOW, which resets U16-5 and terminates the $\overline{\text{IRQ}}$ to U10.

2-22.27 This read-and-write process is followed by the A2 PC Assembly transferring data to the A15 PC Assembly. These two data transfer processes alternate and repeat indefinitely.

2-22.28 Annunciators and Indicators ($48XX, $4CXX) (Sheet 4 of 8). There are 44 light-emitting diodes or diode arrays on the front panel. These solid-state light sources are used to illuminate various annunciator labels and indicators on the front panel, thus permitting visual indication of the instrument's operating mode.

2-22.29 U47 and U52 are CMOS devices designed to drive multiplexed 8-digit common-anode LED displays. Each device has an internal clock generator to produce the various multiplexing signals required for its operation, and is constructed to accept a "No-Decode" input format that permits individual control over each of its 8-segment drivers; this allows the keyboard microprocessor to selectively illuminate any single LED on the front panel. The two sections of U40 invert the data to what would normally be the decimal-point drivers for conventional 7-segment displays, since a HIGH input turns a segment driver on, but a LOW turns a decimal point driver on.

2-22.30 The keyboard microprocessor provides the appropriate address information to U47 and U52. Device selection is accomplished by the $\overline{\text{LED1}}$ and $\overline{\text{LED2}}$ lines.

2-22.31 Data Displays ($50XX). The three liquid-crystal displays on the front panel provide the user with information on the instrument's output frequency, output level, and internal modulation sources.

2-22.32 Data Transfer and Display Selection (Sheet 5 of 8). Data transfer into the various displays uses the four lower order bits (D0 to D3) of the keyboard data bus. U42 provides buffering for these signals. Data destination is determined by the five lowest address bus lines (A0 to A4).

2-22.33 Using address lines A2 through A4, 1-of-8 decoder U17 generates seven $\overline{\text{Chip}}$ Select signals that enable the appropriate receiving devices.

2-22.34 Frequency Display A1U3. A1U6 and A1U7 each contains four addressable latches and circuitry to drive four digits of a liquid-crystal display, to produce digits 0 through 9 and characters H, E, L, P, and – (minus). Each device also contains an oscillator and divider chain which creates the backplane drive signal necessary for liquid-crystal operation; these drivers permit the backplane drive of one device to be slaved to that of another similar device. $\overline{\text{CS1}}$ and $\overline{\text{CS2}}$ determine whether A1U6 or A1U7 is selected, while address lines A0 and A1 determine which latch, and thus which digit in the display, receives data. A1U6 drives the four left-most digits of the display, while A1U7 drives the next four digits.

2-22.35 When enabled by the $\overline{\text{CS3}}$ signal from U17, 1-of-8 decoder U29 determines whether A1U9, A1U10, or the upper or lower half of U35, accepts data.

2-22.36 A1U9 and A1U10 latch their input data and convert it to a 7-segment format for liquid-crystal displays. In conjunction with the backplane drive signal generated by A1U6, they control the two rightmost digits of the frequency display. 1-of-16 decoder U33 determines which decimal point in the frequency display is turned on. Similarly, U34 determines which of the display's cursors (underlines) is turned on. Exclusive-OR gates U24, U26, U27, U25, and U41, in conjunction with the backplane drive signal from A1U6, drive the display's cursors and decimal points. The inputs to the various Exclusive-OR gates determine whether an individual cursor or decimal point is on or off.

2-22.37 Level Display A1U2 (Sheet 6 of 8). A1U8 is a combination latch and liquid-crystal display driver similar to A1U6 and A1U7. $\overline{\text{CS4}}$ enables A1U8, and address lines A0 and A1 determine which digit in the level display receives data. Note that the level display backplane is driven by A1U8, and has no connection to the backplane of the frequency or modulation display.

2-22.38 When enabled by $\overline{\text{CS4}}$, U53 determines the state of the cursors and decimal points of the level display. These elements are controlled by U56 and U54, and driven by U57, U58, and U59.

2-22.39 Modulation Display A1U1 (Sheet 7 of 8). A1U5 is a combination latch and liquid-crystal display driver similar to A1U6 and A1U7. $\overline{\text{CS6}}$ enables A1U5, and address lines A0 and A1 determine which digit in the modulation display receives data.

2-22.40 When enabled by $\overline{\text{CS7}}$, U1 determines the state of the cursors and decimal points of the modulation display. These elements are controlled by U4, and driven by U3 and U5.

2-22.41 Keyboard ($54XX, $58XX) (Sheet 3 of 8). The instrument's front panel contains 48 keyboard switches arranged in a matrix of 10 columns and 6 rows. Controller U51 scans this matrix, indicating to the keyboard microprocessor when a closure key is detected. Crystal Y2, in conjunction with U51's internal oscillator, determines the scan rate of the keyboard.

2-22.42 U51's key column outputs (KC0 to KC3) and key row outputs (KR0 to KR2) can be considered as equivalent to the outputs of a 7-stage binary counter. The key column outputs drive 1-of-10 decoder U50, which produces a HIGH on one of its outputs as determined by the logic states of the key column lines. Meanwhile, the key row outputs instruct 1-of-8 data selector U49 as to which of the 6 rows of the keyswitch matrix will be selected to provide data to U51 through its KR3 input.

2-22.43 So long as no keyswitch is depressed, there is no connection between the key column lines and the key row lines in the switch matrix. U49's five inputs (X0 to X5) will be held LOW by the pulldown resistors of RN4, and therefore U49's Z output will be LOW. If a keyswitch is depressed, the appropriate input to U49 will be HIGH. When the corresponding row line is selected for data transfer to U51, U49 will produce a HIGH output. By keeping track of the "count" of the KC and KR outputs, U51 can determine which key has been pressed.

2-22.44 When a key is pressed, U51 generates an active-low Interrupt Request. The keyboard microprocessor then drives the $\overline{\text{Key}}$ line low, and reads the key code generated by a data register internal to U51. Data register selection is determined by the three address lines A0 to A2. The microprocessor then takes appropriate action, as determined by control software.

2-22.45 U51's three address inputs A0 to A2, along with the active-low ReaD ($\overline{\text{RD}}$) and WRite ($\overline{\text{WR}}$) inputs are used to access registers within the device, permitting the microprocessor to enable and disable interrupts, detect key over-runs, and the like. U51's active-low Repeat ($\overline{\text{RPT}}$) input is enabled for keys which are allowed to operate repeatedly when pressed. This includes the two cursor movement keys, the increment key, and the decrement key.

2-22.46 Interrupt Timing ($5CXX) (Sheet 1 of 8). Programmable timer U12 generates a non-maskable interrupt request at a 1 ms rate. This signal updates a real-time clock register in RAM. The contents of this clock register determines when to change the RF frequency or power level when the instrument is in a sweep mode, and determines the period between display updates, keyboard scans, and intercommunication cycles.

2-23. INTERFACE PC ASSEMBLY, A3

2-23.1 This assembly produces switching signals which control many of the instrument's RF signal-generating components and the RF step attenuator. It also contains circuitry to generate a sweep voltage when the instrument is in a sweep mode. For MATE systems, a Discrete Fault Indicator (DFI) output is provided. All control data is generated by the CPU PC Assembly A15. Refer to figure 5-15.

2-23.2 Interface. The interface transfers control data from the CPU PC board A15, to the Interface PC board A3, and transfers status data from A3 to A15.

2-23.3 Address Detection. U1 is a digital comparator whose A=B output (pin 6) is HIGH when the logic levels at its A inputs (pins 10, 12, 13, and 15) are identical to the logic levels at the associated B inputs (pins 9, 11, 14, and 1, respectively). When the board is addressed, U2's outputs are enabled by a HIGH at U1's A=B output. If the $\overline{\text{DAV}}$ line is LOW, U2 produces a LOW at one output determined by address lines A0 through A2; unselected outputs remain HIGH. A LOW at one of U2's Y outputs determines which of 8 devices (U6 through U10, U14, U17, and U19) is selected for data transfer.

2-23.4 Data Transfer. Data transfer direction is determined by the state of the Read/$\overline{\text{Write}}$ line from the CPU PC Assembly A15. When the tri-state transceiver U5's DIR line is LOW, transfer is from the instrument data bus to A3; when this line is HIGH, transfer is from A3 to the instrument data bus.

2-23.5 Data is written into latches U6 through U10, U14, U17, and U19, when the associated output of U2 moves from HIGH to LOW, the inverters creating a LOW-to-HIGH transition on the CLOCK input. It is this low-to-high transition, not the logic state, that causes the latching action.

2-23.6 Latches. U6 holds four bits used to control the operating mode of the A4 PC board, and the four most significant bits of the RF level data. U7 holds the eight least significant bits of the level data. U8 holds two bits used to control the operating mode of A4 PC board. U9 holds three bits of data used to control the A4 PC board, 1-bit to control the DFI relay, and the two most significant bits of the sweep out voltage data. U10 holds the eight least significant bits of the sweep out voltage data. U14 and U17 each hold eight bits of data used to control Output Module Section 1 Assembly A23. U19 holds seven bits used to control the instrument's step attenuator, A22U1.

2-23.7 Status Information. U21 is a tri-state buffer whose outputs remain in a high-impedance state until its two G lines are low. This event occurs whenever the A3 line on the instrument address bus is HIGH. Under these conditions, data on U21's inputs appears at its outputs. When the A3 PC board is reading data, transceiver U5 will pass the information to the instrument data bus. This permits the CPU to determine the operational status of the leveling loop and reverse power detector.

2-23.8 Sweep Voltage Generator. This circuit generates a 0 to +10 V ramp voltage when the instrument is in a frequency or level sweep mode.

2-23.9 Reference Voltage. U12 is a precision voltage source. It produces a −10.000 V output used as a reference voltage by the digital-to-analog converter (DAC) U11.

2-23.10 Sweep DAC. For a digital input number N between 0 and 1023, U14 produces an output current equal to N/1024 times a current determined by the voltage applied to the reference input (pin 15) of the device. This current is turned into a voltage by U13-1. Circuit output ranges from 0 to +10.0 volts.

2-23.11 When the instrument is in a frequency or level sweep mode, the data in U9 and U10 is updated once per sweep step. This data is such that an output of 0 to +10.0 volts is generated regardless of the number of sweep steps or the difference between the endpoints of the sweep. The data to produce this output is calculated by the Front Panel Interface PC board A2 and transmitted to the Interface PC board A3 via the CPU PC board A15.

2-23.12 Attenuator Driver. This circuit indirectly drives the relays of the step attenuator (A22U1) to control the RF output level in 10-dB steps. The seven bits in latch U20 determine which relays are energized. A HIGH output causes the associated open-collector transistor within driver U20 to turn on. The outputs of U20 drive circuitry on Output Module Section 1 Assembly A23, which in turn drives the step attenuator.

2-23.13 Switch Drivers. U15, U16, and U18 are quad comparators. A +1.4 V reference is applied to the inverting input of each comparator. When the voltage on the non-inverting input is LOW, the corresponding comparator output is at −16 V (nominal). When the voltage on the non-inverting input is HIGH, the corresponding comparator output is at +16 V (nominal). The comparator outputs are applied to circuits on Output Module Section 2 Assembly A22 and Output Module Section 1 Assembly A23.

2-23.14 Discrete Fault Indication (DFI). Relay K1 is normally closed, and its contacts are brought out to a connector on the instrument's rear panel. During normal operation, the A15 PC board will set the appropriate bit of latch U9 HIGH, causing Q1 to turn on and energize the relay, opening its contacts. When a fault occurs, the relay will be de-energized, informing the MATE system controller that a fault exists. Since the relay is normally closed, this method will even detect an instrument which is not turned on.

2-24. LEVEL CONTROL PC ASSEMBLY, A4

2-24.1 The Level Control board, in conjunction with circuitry on A6, A22, and A23, controls the instrument's RF output level. The CPU PC board A15 controls the Level Control PC board through the Interface PC board A3. Refer to figure 5-18.

2-24.2 Reference Voltages. U7 is an integrated circuit which simulates an extremely stable Zener diode with a very low temperature coefficient. The output voltage of this device is nominally −6.9 V. U6-7 reduces and inverts U7's output to produce +5.12 V, which is again inverted by U6-1 to produce −10.24 V.

2-24.3 Modulation Inputs. These circuits select the signal source(s) used to modulate the amplitude of the instrument's RF output.

2-24.4 External AM Input. An external amplitude modulation (AM) signal is applied to the Level Control PC board through J6. R1 provides a nominal 600 ohm input, while CR1 through CR4 provide protection against excessive input voltages.

2-24.5 AC and DC Coupling. The external AM input signal is applied to solid-state switch U1 through R2, R3, C1, and C2. When U1's control input is HIGH, the switch provides a dc path for the external AM signal. When the control input is LOW, the external AM signal passes through the capacitors.

2-24.6 Differential Amplifier U2-1 buffers the external AM signal and eliminates the effects of any ground loops or voltage offsets between the Level Control PC board and the external AM input connector.

2-24.7 Modulation Source Selection. The external AM input from U2-1 is applied to solid-state switch U3. When external AM is selected, the switch between pins 16 and 1 is closed, and the switch between pins 4 and 3 is open; otherwise, the switch between pins 16 and 1 is open, and the switch between pins 4 and 3 is closed.

2-24.8 The internal AM signal is also applied to U3. When internal AM is selected, the switch between pins 9 and 8 is closed, and the switch between pins 5 and 6 is open; otherwise, the switch between pins 9 and 8 is open, and the switch between pins 5 and 6 is closed.

2-24.9 When neither internal nor external AM is selected, the switches between pins 8 and 9, and between pins 16 and 1 are open, and the switches between pins 5 and 6, and between pins 4 and 3 are closed.

2-24.10 Both the internal and external AM sources may be simultaneously applied and selected.

2-24.11 Level Control Voltage Generation. This circuit generates a level control voltage representing the RF output power desired from the instrument.

2-24.12 Summing Amplifier. R10 applies the +5.12 V reference to summing amplifier U2-7, which inverts this voltage to create a −5.12 V dc output. Gain for the AM signals selected by U3 is set by R6 and R7, so that for modulating signals of 1 V peak, the output of U4 will vary from 0 V to precisely twice the reference voltage (−10.24 V).

2-24.13 Level Control Voltage. The output from U2-7 is applied to multiplying DAC U5. Twelve bits of level data are applied to the digital control inputs of the DAC. For any digital input number N from 0 to 4095, U5 produces an output current equal to N/4096 times a current determined by the voltage applied to pin 17 of the DAC. U8-1 converts this current into a voltage. Feedback is provided by a 10 kΩ resistor internal to U5.

2-24.14 U5's digital input represents the CW RF output voltage that the instrument is to produce. This data is scaled so that an RF output of 1 V rms (+13 dBm) is represented by +2.56 V from U8-1. CPU PC board A15 transfers all level data through the Interface PC board A3 to the Level Control PC board A4.

2-24.15 When the AM modulation mode is selected, the voltage at U5's reference input varies in accordance with the instrument's modulation input. So long as the amplitude of the modulation input is constant, the relationship between the amplitudes of the dc and ac components of the reference voltage at U2-7 remains constant. This voltage is scaled by the multiplying DAC U5 to provide a level control voltage at U8-1 with the AM signal superimposed. This method permits a constant AM depth regardless of the programmed RF level.

2-24.16 Max Power On. Circuitry (U8, Q1, and associated components) is provided to cause the instrument to produce the maximum available unleveled RF power at its output. This condition is helpful during the manufacturing process and is not available to the instrument operator.

2-24.17 Level Control Loop. The RF detector circuit on Output Module Section 1 Assembly A23 provides a voltage proportional to RF level. This voltage is compared to the level control voltage generated by the DAC U5 and the level control loop modifies the RF level to make these two signals exactly equal. The detector signal from A23 PC Assembly enters the A4 PC Assembly at J4. U9 is an inverting summing amplifier which compares the detector signal to the level control voltage at U8-1. The output of U9 represents the level error.

2-24.18 Bandwidth Switching Non-Pulse Mode. The level control loop is a first order, type 1 closed-loop system. Amplifier U11 is the loop compensating network which controls the loop bandwidth. At output frequencies above 10 MHz the switch corresponding to pins 2 and 3 of U10 (CMOS switch) is closed; all others are open. In this condition the level control loop bandwidth is nominally 100 to 200 kHz. At frequencies below 10 MHz the time-constant used on A23 to integrate the detector output must be reduced to properly filter the RF signal. For the level control loop to remain stable the loop bandwidth must be reduced. This is achieved by increasing the value of the input resistor to U11-1. For output frequencies in the range of 1 to 9.999999 MHz the switch corresponding to pins 6 and 7 of U10 is closed; all others are open; the loop bandwidth in this condition is nominally 10 kHz. For frequencies below 1 MHz the switch corresponding to pins 11 and 10 of U10 is closed; all others are open; the loop bandwidth in this condition is nominally 1 kHz.

2-24.19 Bandwidth Switching Pulse Mode. Level control during pulse modulation is achieved by sampling the error voltage during the pulse (RF on) and holding this voltage until the next pulse. This is achieved by sample and hold amplifier U15. The signal applied to the front panel pulse input appears at A4-J5. R108 provides a 50-ohm termination to this input. If pulse is not selected, U16-8 is HIGH which pulls U18-2 HIGH. In this condition the comparator output U18-7 is HIGH which causes the pulse modulator drive output at J3 to be HIGH, thereby holding the pulse modulator in the ON position. When pulse is selected, the comparator output pulses according to the pulse input signal causing the pulse modulator drive output to pulse. When the pulse modulator is in the RF ON condition the voltage at J3 is nominally +4 to +5 V. When the RF is OFF, the voltage is nominally −15 V.

2-24.20 Dual monostable U17 generates the sample and hold control signal. The negative edge of the pulse at U18-7 triggers the monostable circuit causing a 4 microsecond pulse to occur at U17-12. If pulse is not selected the NAND gate U16-3 isolates the sampling pulse from the sample and hold amplifier. If pulse is selected the sampling pulse is inverted by U16-3, re-inverted by U16-6, and then applied to the sample input of U15.

2-24.21 U15 then samples the error voltage of U9-6 during the pulse ON period. This voltage is then applied to compensating amplifier U11-1 via R40. When pulse is selected the switch associated with pins 5 and 15 of U10 is closed; all other switches are open. In this condition the level control loop bandwidth is nominally 1 Hz, allowing pulse repetition rates down to 10 Hz.

2-24.22 The output of U11-1 is amplified by U11-7 and applied to the PIN leveler linearizing circuits U13-1 and U14-1.

2-24.23 PIN Leveler Drivers. The PIN levelers are current controlled devices used to control the RF level. The effective gain of these devices (rate of change of attenuation vs current) varies over the attenuation range. This variation must be compensated for in order to maintain the nominal 100 to 200 kHz bandwidth necessary for high AM rates and low distortion. This is the purpose of the piece-wise linearizing circuits of U13-1 and U14-1.

2-24.24 Amplifiers U13-7 and U14-7 provide attenuation and dc offsets to scale the linearizer outputs to the nominal 2 to 5 V required for the levelers. U14 provides drive signals for the leveler A22A1 which is used for frequencies up to 1499.999999 MHz. U13 provides drive signals for the leveler A22A11 which is used for frequencies above 1.5 GHz.

2-24.25 When output frequencies above 1.5 GHz are required, the A22A1 leveler must be at a minimum attenuation. This is achieved by Q2, Q3, Q4, and associated circuitry which pulls U14-3 negative resulting in a voltage of approximately +5 Vdc at J2.

2-24.26 Fault Detectors AM Status. The window comparator circuit formed by dual op-amp U4 monitors the AM signal. If the voltage at U2-7 falls below −10.24 V, U4-14 changes state, going LOW which pulls the circle 1 pin to a TTL LOW condition indicating positive AM overrange. If the voltage at U2-7 goes above 0 V, U4-13 changes state, going LOW which pulls the circle 2 pin to a TTL LOW condition, indicating negative AM overrange.

2-24.27 Level Loop Status. The window comparator circuit formed by dual op-amp U12 monitors the pre-linearized leveler control voltage. If the programmed RF level cannot be achieved for any reason, the level control loop will saturate; in this condition the voltage at U11-1 will be approximately −15 Vdc. This causes U12-2 to go LOW which pulls the circle A pin to a TTL LOW condition, indicating underpower. If the level control loop saturates negative for any reason (e.g. faulty leveler) the voltage at U11-1 will be approximately +15 Vdc. This causes U12-1 to go LOW which pulls the circle B connector to a TTL LOW condition, indicating overpower.

2-24.28 Multiple Faults. Application of an extremely large modulation signal may cause a Level Loop Status fault as well as one or both of the AM Status faults. The instrument will announce a Level Loop Status fault in preference to an AM Status fault if both types should occur.

2-24.29 Power Supplies. Transistor array U20 is configured as a combination beta multiplier and current limiter for the Level Control PC board.

2-24.30 So long as the current drawn by the +15 V supply is less than about 200 mA, the voltage across R110 will be too low to cause U20-2 to conduct. As a consequence, U20-6 will act as a beta multiplier, reducing the amplitude of any line-related modulation on the supply before its application to circuits on the PC board. However, if sufficient current flows through R110 to cause U20-2 to conduct, it will begin to divert the base bias for U20-6, thus limiting the current which may be applied to the PC board.

2-24.31 Save that the limiting current for the −15 V supply is about 60 mA, the operation of U20-9 and U20-13 is identical.

2-25. AUDIO SYNTHESIZER PC ASSEMBLY, A5

2-25.1 The Audio Synthesizer produces sine wave signals from 10.00 Hz to 99.99 kHz in four decade steps, with four decimal digits of frequency resolution and 1000 steps of amplitude resolution. The 1500 Series contains two Audio Synthesis PC boards A5A (AM) and A5B (FM), which provide modulating signals for internal AM and internal FM. Refer to figure 5-22.

2-25.2 Interface. The interface transfers data between A15 the CPU and A5.

2-25.3 Address Detection. U1 is a digital comparator whose A=B output (pin 6) is HIGH when the logic levels at its A inputs (pins 10, 12, 13, and 15) are identical to the logic levels at the associated B inputs (pins 9, 11, 14, and 1, respectively). As there are two PC boards in the instrument, jumper W1 permits the address to be changed so that each PC board can be individually addressed.

2-25.4 When the board is addressed and the $\overline{\text{DAV}}$ line is LOW, U2 produces a LOW level at one output determined by address lines A0 through A2;

unselected outputs remain HIGH. A LOW at one of U2's Y outputs determines which of five devices (U6 through U10) is selected for data transfer.

2-25.5 Data Transfer. Data transfer direction is determined by the state of the Read/$\overline{\text{Write}}$ line from the CPU A15. When tri-state transceiver U3's DIR (Read/$\overline{\text{Write}}$ input) line is LOW, transfer is from the instrument data bus to the Audio Synthesizer PC board; when this line is HIGH, transfer is from the Audio Synthesizer PC board to the instrument data bus. U3's outputs are enabled by a HIGH at U1's A=B output.

2-25.6 Data is written into latches U7 through U10 when the associated output of U2 moves from HIGH to LOW, the inverters (U5) creating a LOW-to-HIGH transition on the Clock input. Note that it is the transition, not the logic state, that causes the latching action.

2-25.7 Latches. Latches U7 and U8 hold 16 bits comprising four decimal digits which control the audio synthesizer's output frequency. U9 stores the eight least significant bits of output amplitude data. U10 stores the two most significant bits of audio amplitude data, two bits which determine the assembly's output frequency decade (e.g. 10-100 Hz, 100-1000 Hz, etc.); and one bit which holds an enable control signal that switches when the PC board's output is on or off.

2-25.8 Status Information. U6 is a tri-state buffer whose outputs remain in a high-impedance state until its two $\overline{G}$ lines are low. When this occurs, data on its input pins is transferred to the output pins. When the A5 PC board is addressed and the CPU A15 is reading data, transceiver U3 will pass the information to the instrument data bus. This permits the CPU to determine the operational status of the rate multipliers.

2-25.9 Rate Multipliers (Sheet 2 of 2). This circuit produces frequencies from 1.000 to 9.999 MHz which are proportional to the desired output frequency of the assembly.

2-25.10 10 MHz Clock Buffer. U5 buffers the 10-MHz clock signal generated by the Reference Frequency Generator PC board A14. The clock inputs of the two audio synthsizer boards are connected in parallel.

2-25.11 Decade Rate Multipliers. When programmed to a number N between 0 and 9, a decade rate multiplier produces N output pulses for each 10 input pulses. The interconnection of the four rate multipliers (U13, U14, U15, and U16) and U17 is such that if the rate multipliers are programmed with values N4 to N1 (most to least significant), U17's output will produce (1000[N4] + 100[N3] + 10[N2] + 1[N1]) pulses for each 10,000 input pulses. Since the input frequency is a fixed 10 MHz, the numbers N4 through N1 control the circuit's output frequency, generating a signal from 1.000 to 9.999 MHz.

2-25.12 Decade Selector. This circuit divides the output frequency of U17 by 10, 100, and 1000; and, selecting between U17's output and that of one of the dividers, produces a frequency 100 times that of the assembly's desired output.

2-25.13 Dividers. U18 contains a single decade divider, and U19 contains 2 decade dividers in a single package. These dividers are interconnected in such a fashion as to produce divisions of 10, 100, and 1000, generating outputs of 100.0 to 999.9 kHz, 10.00 to 99.99 kHz, and 1.000 to 9.999 kHz respectively, when provided with an input of 1.000 to 9.999 MHz. These frequencies and the 1.000 MHz to 9.999 MHz signal from U17 are applied to U20. The logic levels at the decade select lines (DS1 and DS2) determine which signal appears at U20's Y output (pin 5). The inverse of the Y output appears at the W output (pin 6).

2-25.14 Decade Selection. If DS1 and DS2 are both LOW, the 1.000 kHz to 9.999 kHz signal from U19 pin 7 appears at the Y output. If only DS1 is HIGH, the 10.00 kHz to 99.99 kHz signal from U19 pin 9 is present. If only DS2 is HIGH, the 100.0 to 999.9 kHz signal from U18 pin 12 is present, and if both DS1 and DS2 are HIGH then the undivided 1.000 to 9.999 MHz signal from U17 appears at the output.

2-25.15 Sine Wave Generator and Filter. This circuit divides the frequency of the signal from U20 by 100 and converts it to a low-distortion sine wave at the desired output frequency.

2-25.16 Counters. When the Enable Control lines of synchronous decade counters U21 and U22 are LOW, the four Q outputs of each counter are held LOW. When Enable is HIGH, each counter divides the frequency at its input by a factor of 10. The two dividers are cascaded to produce a division by a factor of 100.

2-25.17 Decimal to Sine Conversion. The outputs of U21 and U22 are applied to the address inputs of programmable read-only memory (PROM) U23, which stores a decimal-to-sine conversion table with 100 states. The PROM's outputs are applied to DAC U24.

2-25.18 For a digital input number N between 0 and 255, the DAC produces an output current equal to N/256 times the current through R7; this current is determined by the voltage across reference diode VR1. As U21 and U22 count through 100 steps, the data in U23 causes the output current from U24 to vary in such a fashion as to produce a single sinusoidal cycle. If the clock input frequency to U21 and U22 is, for example, 100 kHz, the output of U24 will be a sinusoidal current at 1-kHz rate.

2-25.19 U25 converts U24's output current into a voltage. R9 and R10 provide an offset current so that the output of U25 is centered on 0.00 volts.

2-25.20 Harmonic Filters. R13 and C10 through C17 form an RC filter which attenuate harmonics of U25's output. Note that the most significant harmonic is the 100th; this is the clock frequency of U21 and U22. The logic states on the control inputs (pins 11, 10, and 9) of analog switch U26 determine which capacitor is selected. U12 detects occasions when the most significant digit of the rate data is set to a value between 3 and 9.

2-25.21 Level Control and Output. This circuit controls the output level of the assembly's sine wave signal.

2-25.22 Amplitude Control DAC. The sine wave from U25 is applied to the reference input (pin 15) of multiplying DAC U27. For digital input number N between 0 and 1023, U27 produces an output current equal to N/1024 times a reference current determined by the voltage at the reference input. U28 converts the output current of U27 into a voltage. Feedback for U28 is provided by C7 and a 10 k ohm resistor internal to U27, connecting between pins 2 and 16. A filter formed by C8 and L2 reduces the harmonic content of the output signal above 330 kHz. Jumpers W6 and R18 provide the appropriate interconnections.

2-25.23 Jumper Selection. Jumper W7 or W8 is installed as appropriate for the PC board's use as the internal AM or FM source.

2-25.24 Fault Detector. This circuit detects the presence of circuit faults which might exist in the assembly.

2-25.25 A signal on U20's W output couples through C2 and CR1 to the base of Q2, pulling the base towards ground. This turns the transistor on and causes its collector to approach +5 V. If a fault on the Audio Synthesizer PC board should occur, U20's output will cease; this will cause the base of Q2 to approach +5 V and its collector to approach ground. The collector of Q2 is connected to the input of tri-state buffer U6. The CPU A15 periodically interrogates each PC board, and, when reading U6, would discover and announce the presence of such a fault.

2-25.26 12-Volt Regulators. To improve output amplitude stability the +17 and −17 V supplies are regulated by U29 and U30 to +12 and −12 volts.

2-26. DOWNCONVERTER PC ASSEMBLY, A6

2-26.1 The Downconverter mixes an 800.1-MHz to 1049.999 999-MHz signal from Output Module Section 2 A22 with a locally-generated 800-MHz signal to produce the low-frequency RF output of 0.1 to 249.999 999 MHz. Refer to figure 5-25.

2-26.2 Loop 8, 800 MHz Phase-Locked Loop (Sheet 1 of 2). This circuit creates an 800-MHz signal which is phase-locked to a reference signal from the Reference Frequency Generator PC Assembly A14.

2-26.3 800 MHz Voltage-Controlled Oscillator. Varicap CR2, C57, and trace inductance determine the frequency of oscillation of Q7. As the capacitance of CR2 is determined by the voltage applied across it, the oscillator's frequency can be controlled by varying this voltage. The oscillator's operation depends in large, on the various parasitic reactances, thus the physical construction of the circuit is critically important. An emitter current of about 20 mA is provided via Q6 when that transistor is switched on by Q9, which, in turn, is controlled by interface circuitry on the Loop 1 IF PC board A8.

2-26.4 RF Amplifier. The oscillator's 800-MHz output is applied to the input of amplifier U7, whose output is coupled through C50 to J4, and through C51 to a resistive power splitter. R34 couples the oscillator signal to the mixer section while R33 connects the 800-MHz signal through C47 to the input of amplifier U6.

2-26.5 ECL Dividers. UHF counter U4 divides its 800-MHz input by a factor of four to produce a 200-MHz output. R27 provides an input pulldown and prevents U4 from oscillating at approximately 400

MHz. U2 divides U4's output by 2 to produce a final output of 100 MHz.

2-26.6 Mixer Phase Detector. The divider output is applied to Q2, whose output is then coupled to the LO input of mixer U1. A 100-MHz reference from the A14 PC board is applied to Q1, whose output is then coupled to the RF input of mixer U1.

2-26.7 U1 mixes these two 100-MHz input signals and produces an output proportional to the phase difference between them. If these signals are not at the same frequency then U1 produces outputs which are the sum and difference of its two input frequencies.

2-26.8 Error Amplifier. The mixer's IF output is applied through a 50-MHz lowpass filter to the input of U5, which behaves as an error amplifier or a Wein bridge oscillator, depending on its input conditions.

2-26.9 Loop Acquisition. If the VCO frequency is not exactly 800 MHz the loop is not locked; it is therefore in an open-loop condition. A circuit is required that will sense this condition and modify the VCO tuning voltage, bringing its frequency to exactly 800 MHz and allowing the loop to lock. This is achieved by the positive feedback network around U5 comprising R25, R26, C48, and C41. When the phase-locked loop is unlocked the U5 amplifier is caused to oscillate by this network at a frequency of around 1.6 kHz. As the amplifier output voltage varies with this oscillation so the VCO frequency is swept. At the instant when the VCO frequency crosses 800 MHz precisely the two input frequencies to U1 are identical, at 100 MHz, and the output of the mixer phase detector becomes a dc voltage proportional to the phase difference between the two input signals. This dc component is amplified by U5 and applied to the VCO input. The negative feedback effect of the loop now causes this voltage to vary in such a way as to hold the VCO frequency at exactly 800 MHz. The negative feedback which now exists around the loop stabilizes U5 and its local oscillation at 1.6 kHz can no longer be maintained. The circuit is now in the closed-loop condition; all voltages settle at their final value and the VCO is held phase-locked at exactly 800 MHz. Should the loop break lock for any reason the U5 stage will begin oscillation again and the loop will relock.

2-26.10 Downconverter (Sheet 2 of 2). This circuit mixes the Loop 8, 800-MHz signal with an 800.1- to 1049.999 999-MHz signal from Output Module Section 2 A22 and Loop 1 to produce a signal with a frequency between 0.1 and 249.999 999 MHz.

2-26.11 Downconversion. The 800-MHz signal from U7 is fed into amplifier U12. This amplifier develops nominally +10 to +13 dBm for the LO drive to the mixer. C82 is provided for the reduction of the third harmonic of the 800-MHz LO signal which causes a spurious signal in the IF when output frequencies towards 249 MHz are requested.

2-26.12 An 800.1 to 1049.999999 MHz signal generated on Output Loop PC Assembly A7, appears at A6-J2 and is applied to the RF port of mixer U8 after passing through a 12 dB pad. This RF signal does not come directly from A7 but passes through the Leveler Amplifier PC Assembly A22A1, the Pulse Modulator PC Assembly A22A2, and the HF Switch PC Assembly A22A3 allowing the level control and pulse modulation to be applied prior to downconversion.

2-26.13 Power Amplifier. The 0.1 to 249.999 999 MHz output from the lowpass filter is applied to amplifier combination U13, U14, which produces about +8 dBm at its output. This signal drives a high-power amplifier Q11, which produces an output of approximately +18 to +20 dBm. This signal passes through a low pass filter to J3 and then to Output Module Section 1 A23.

2-26.14 Fault Detection. These circuits detect the presence of circuit faults which may exist in the assembly.

2-26.15 Lock Detector. If the frequency of the 800 MHz VCO is phase-locked to the 100-MHz reference signal, the output of U5 will be a dc voltage. If, however, the VCO is not phase-locked to its reference, the output of U5 will be a low-frequency oscillation. Any ac component of the voltage on U5's output will be coupled through C37, rectified by CR1, and applied to the inverting input of comparator U3. If this voltage exceeds about 3.3 V, U3's output transistor will turn on, creating an output of 0 V. The output of U3 is connected to interface circuitry on the Loop 1 IF PC board A8 where it will be sensed by the CPU as a fault.

2-26.16 Power Supply Filters. Q12, Q13, and Q14 are beta multipliers which reduce any line-related signals on the instrument power supplies before their application to critical circuits on the PC board.

2-27. LOOP 1 PC ASSEMBLY A7

2-27.1 This PC board contains three voltage-controlled RF oscillators which produce outputs from 250 to 500 MHz, 500 to 1000 MHz, and 1000 to 1500

MHz. The frequency of the selected oscillator is phase-locked to the outputs of Loop 2, Loop 5, and either Loop 9 (when frequency modulation is desired) or a 100-MHz signal from A14 (when frequency modulation is not required), to produce the instrument's RF output signal. Refer to figure 5-28.

2-27.2 Loop 1 RF Signal Generation and Control 250- to 500-MHz Oscillator (Sheet 2 of 2). This oscillator is a standard Colpitts type. Varicaps CR4 and CR5 and inductance L5 determine Q6's frequency of oscillation. Q7 buffers the oscillator's output and applies it to amplifier U6, whose output passes through a 750-MHz low-pass filter to the RF switch formed by CR12, CR13, and CR14. Q10 applies dc power to the circuit and switches on CR12 when this oscillator is selected.

2-27.3 500- to 1000-MHz Oscillator. This is a parallel-tuned negative-impedance oscillator. Varicaps CR7, CR8, and printed inductors determine Q8's frequency of oscillation. The oscillator output is applied to amplifier U7, whose output is fed to the RF switch formed by CR12, CR13, and CR14. Q11 applies dc power to the circuit and switches on CR13 when this oscillator is selected.

2-27.4 1000- to 1500-MHz Oscillator. This is a series-tuned negative impedance oscillator. Varicaps CR10 and CR11, capacitor C60 and the inductance of the base connection to Q9 determine Q9's frequency of oscillation. The oscillator signal is applied to amplifier U8, whose output is applied to the RF switch formed by CR12, CR13, and CR14. Q12 applies dc power to the circuit and switches on CR14 when this oscillator is selected.

2-27.5 Oscillator Selector Switch. PIN diodes CR12, CR13, and CR14 form a 3-input, 1-output RF switch which applies the selected oscillator signal to amplifier U9. The output of amplifier U9 feeds amplifier U10 and, after attenuation, amplifier U13. The output from amplifier U10 passes through a 3-dB pad to provide a nominal level of +3 dBm at J5. This is the main signal output and is fed to A22 PC Assembly. The output from amplifier U13 is attenuated to provide a nominal −12-dBm level at J4. This signal is applied to A8 PC Assembly and is part of the feedback path for phase lock.

2-27.6 Phase Lock Process (Sheet 1 of 2). In conjunction with circuitry on the Loop 1 IF PC board A8, the frequency of the Loop 1 oscillator is phase-locked to signals generated elsewhere in the instrument.

2-27.7 Frequency Conversions on A8. Loop 2 (on A9) generates a 272- to 544-MHz signal which moves in 1-MHz increments. Loop 2's output frequency is multiplied by 1, 2, or 3, depending on whether Loop 1's output is 250 to 500 MHz, 500 to 1000 MHz, or 1000 to 1500 MHz, respectively. The multiplied signal, which moves in 1-, 2-, or 3-MHz steps depending on the multiplication factor, is mixed with the Loop 1 signal to produce an IF signal ranging from 42 to 45 MHz. This signal is then mixed with a 50-MHz signal from Loop 9. The 50-MHz signal may be frequency modulated. The output of this second conversion process is an IF which ranges from 5 to 8 MHz. This second IF is returned to the Loop 1 PC board.

2-27.8 Phase Lock Process. The 5- to 8-MHz signal from A8 is applied to one input of phase detector U2, whose other input is a 5- to 8-MHz signal which is the output of Loop 5 (on A13) divided by 50 (by A12). The frequency of this second signal is controlled in 1-Hz steps, and ranges from 5 to 6 MHz, 5 to 7 MHz, or 5 to 8 MHz depending on which of Loop 1's oscillators is selected.

2-27.9 U2 produces negative-going ECL-compatible output pulses whose widths are proportional to the phase differences between its two input signals. These pulses are amplified and integrated by U3, which produces a dc voltage proportional to the difference in the widths of the pulses at U2's outputs.

2-27.10 U3's output voltage receives additional filtering by R18, R19, and C15, and is then applied through a 5-MHz low-pass filter to the inverting input of summing amplifier U5-7. The coarse tune voltage from A8 PC Assembly is amplified by U5-1 and applied to the non-inverting input of the summing amplifier.

2-27.11 Linearizer. Due to the nature of the voltage-versus-capacitance relationship of varactor diodes, a tuned circuit using such devices must have its tuning voltage change by a factor of at least 16:1 for a 2:1 change in frequency, depending on the ratios of the fixed and variable capacitances in the circuit. These effects are minimized by Q3, Q18, and associated circuitry which forms a switched attenuator at the input to the VCO's, controlled by the A15 CPU PC Assembly. These FET's are turned on and off according to the programmed output frequency. As a result the effective VCO sensitivity is held relatively constant.

2-27.12 Kicker. It is possible during acquisition for the loop to latch up with U3-6 saturated on its negative rail. Should the microprocessor determine that an unlock condition has existed for more than 2 msec it applies a 2 msec pulse to the circle R connector, "Loop 1 Kick", turning on Q2 and forcing the output of U3 to go to its positive rail. When this pulse resets, turning Q2 back off, the output of U3 is steered negative by the phase detector U2 which acts as a frequency discriminator when the loop is not locked. As the U3-6 output voltage varies, so does the VCO frequency which in turn determines the frequency of the signal at A7-J2. When the two input signals to the phase detector are at the same frequency the loop locks.

2-27.13 Lock Detection. Since when the loop is unlocked amplifier U3-6 has "infinite" dc gain, a steady state unlock condition will result in a railed output from this device (there is no dc feedback path from pin 6 to pin 2; when the phase-locked loop is unlocked the dc gain of this stage is limited only by the characteristics of the op-amp). The existence of this condition is relayed to the microprocessor by the window detector circuit formed by U12-1 and U12-7 which causes a LOW level to appear at circle C, "Loop 1 Status", when the output voltage of U3-6 is outside the range ±12 Vdc. The CPU PC Assembly A15 will detect this state and instruct A2 PC board to display the appropriate error code on the instrument front panel.

2-27.14 Supply Filters. Q4, Q5, Q16, Q17, and the transistors in array U11 form beta multipliers which reduce the amplitude of any line-related modulation on the instrument power supplies before their application to critical circuits on A7 PC board. These circuits also limit the current provided by each supply to avoid destroying the regulating transistors should a short circuit or overload condition occur.

2-27.15 Considering the −6.5 V power supply, if the current drawn by the PC board is low, the voltage across R104 will be less than the amount necessary to cause Q4 to turn on. If the voltage across R104 exceeds about 0.7 V, however, Q4 turns on, diverting base current from Q5 and limiting the current supplied to the PC board. R97 permits adjustment of the output voltage to the −5.2 V required by ECL logic.

2-27.16 The operation of the remaining circuits is identical.

2-28. LOOP 1 IF PC ASSEMBLY A8

2-28.1 This board contains circuitry to implement the mixing process required to phase lock the Loop 1 oscillators on A7. It also produces "coarse tune" voltages for the Loop 1 and Loop 2 oscillators, and generates a number of switch lines used to control many circuits within the instrument. An interface to the system data bus permits A15 CPU PC Assembly to exercise control over these functions. Refer to figure 5-31.

2-28.2 Interface (Sheet 1 of 2). The interface transfers control data between the CPU PC board A15 and Loop 1 IF PC board A8 via the instrument interface bus.

2-28.3 Address Detection and Selection. U22 is a digital comparator whose A=B output (pin 6) is HIGH when the logic levels at its A inputs (pins 10, 12, 13, and 15) are identical to the logic levels at the associated B inputs (pins 9, 11, 14, and 1, respectively). When the board is addressed and the $\overline{\text{DAV}}$ line is LOW, U23 produces a LOW level at one output determined by address lines A0 through A2; unselected outputs remain HIGH. A LOW at one of U23's Y outputs determines which of seven devices (U13 through U17, U20 or U21) is selected for data transfer.

2-28.4 Data Transfer. The direction of data transfer is determined by the Read/$\overline{\text{Write}}$ line from the CPU. When tri-state transceiver U24's DIR line is LOW, transfer is from the instrument data bus to the A8 PC board; when this line is HIGH, transfer is from A8 to the instrument data bus. U24's outputs are enabled by a HIGH at U22's A=B output.

2-28.5 Data is written into latches U15 through U17, U20 or U21 when the associated output of U12 moves from HIGH to LOW, the inverters creating a LOW-to-HIGH transition on the Clock input of the selected latch. Note that it is the transition, not the logic state, that causes the latching action.

2-28.6 Latches. U20 holds 8 bits which control the coarse tune voltage applied to the Loop 1 oscillators on A7. U21 holds 8 bits which control the coarse tune voltage applied to the Loop 2 oscillator on A9. U17 holds 7 bits which control selection of the Loop 1 oscillators, the ON/OFF condition of the downconverter, the amount of linearization applied to Loop 1's control voltage, and the switching of a "kicker" circuit on Loop 1. U16 holds 6 bits, which are applied to the A9 and A14 PC boards to select the source(s) used for FM modulation, and the required FM sensitivity. U15 holds 5 bits which control the coarse tune voltage for Loop 3 (on A10 PC Assembly), and a frequency change signal which controls the state of analog switch U4.

2-28.7 Status Information. U13 and U14 are tri-state buffers whose outputs remain in a high-impedance state until each device's two $\overline{G}$ lines are low. Selection of these buffers is controlled by U23. When this occurs, data on the buffer's input is transferred to its output. If the CPU A15 is reading data at that time, U24 will pass the information to the instrument data bus. This permits the CPU to determine the operational status of Loops 1 through 4, Loop 8, Loop 9, and the Reference Frequency Generator PC Assembly A14.

2-28.8 Coarse Tune Voltages. These voltages are used to tune the Loop 1 and Loop 2 oscillators to RF frequencies which are within range of their phase detector circuits.

2-28.9 Reference Voltage. U18 is a precision voltage source which produces an output of −10.00 V used as a reference voltage for DAC's U10 and U11.

2-28.10 Loop 1 Coarse Tune Voltage. Latch U20 provides information which determines the coarse tune voltage used by Loop 1. Note that the two least significant inputs of DAC U10 are not used. For a digital input number N between 0 and 255, the DAC produces an output current equal to N/256 times a current determined by the voltage applied to the reference input (pin 15) of the device. This current is turned into a voltage by U7-1. Feedback for U7-1 is provided by C39 and a 10 k-ohm resistor internal to the DAC.

2-28.11 The output voltage from U7-1 covers a 0 to 10 V nominal range. This signal passes through the switched filter circuit of R14 and C36 and a low impedance output is provided by buffer amplifier U7-14. The buffer's output is applied through J1 to A7, the Loop 1 PC board. When the instrument is operating at a fixed frequency, the control line to U4-15 is LOW, the switch between U4-1 and U4-16 is open, and R14 and C36 provide filtering of the coarse tune voltage, decreasing noise on the instrument's RF output. When the RF frequency is changed, however, the control line goes HIGH, the switch closes, and R14 is shunted by the low resistance of the switch; this permits U7-1 to change the voltage on C36 rapidly, decreasing the time required for the instrument to settle at the new frequency of U19. After settling has occurred, the control line goes LOW again and the switch opens.

2-28.12 Loop 2 Coarse Tune Voltage. Latch U21 provides information which determines the coarse tune voltage used by Loop 2. Note that the two least significant inputs of DAC U11 are not used. For a digital input number N between 0 and 255, the DAC produces an output current equal to N/256 times a current determined by the voltage applied to the reference input (pin 15) of the device. This current is turned into a voltage by U7-7. Feedback for U7-7 is provided by C40 and R30.

2-28.13 The output voltage from U7-7 covers a 0 to +15 V nominal range. This signal passes through the switched filter circuit of R13 and C37 and a low impedance output is provided by buffer amplifier U7-8. The buffer's output is applied through J2 to the Loop 2 oscillator on A9. Noise reduction switching for this circuit is the same as for the Loop 1 coarse tune voltage, employing switch contacts pins 3 and 4 of U4.

2-28.14 Control Signals. The interface circuitry on the A8 PC Assembly provides control signals and status reporting for the A7 PC Assembly, A9 PC Assembly, A10 PC Assembly, and A14 PC Assembly.

2-28.15 Loop 1 Switching. The CPU PC Assembly A15 determines the data written into latch U17.

2-28.16 Seven outputs from U17 are applied to the inputs of open-collector driver U19. Three of these signals are used to turn on the appropriate output oscillator on the Loop 1 PC Assembly A7. A HIGH at the input of U19 turns the associated transistor on. When the appropriate output of U17 is high, a source of base current is provided for the associated transistor (Q9, Q11, or Q12), turning it on and causing its collector to approach +15 V. This voltage will turn on the appropriate transistor on the A7 PC board, simultaneously enabling the correct Loop 1 oscillator and applying its output to the output of the PC board.

2-28.17 The Osc2 On line also drives a bi-polar switch (Q6 and Q7) used to control the operation of the doubler circuitry on A8 PC Assembly. Q8 provides a current limiter function for this control line.

2-28.18 The four remaining outputs from U19 select the amount of linearization applied to the control voltage for the Loop 1 oscillators, determine whether the downconverter, A6 PC Assembly, is activated, and control the output loop kicker circuit.

2-28.19 Other Switching Functions. Data from the A15 PC board is latched by U15 and U16 to control functions on the A10 and A9 PC boards, respectively. Q10 inverts one of these lines to provide an active-low, open-collector output required by A14 PC Assembly to switch the 100-MHz output it applies to A9 PC Assembly.

2-28.20 Loop 1 Frequency Conversion Processes (Sheet 2 of 2). These circuits are part of the phase-locked loop that controls the frequency of Loop 1, which produces the instrument's RF output signal.

2-28.21 Multiplication of Loop 2 Output. Loop 2 produces a 272- to 544-MHz output with 1-MHz resolution. This signal is multiplied by 1, 2, or 3 to produce a frequency which, when mixed with the 250- to 1500-MHz output of Loop 1, will produce an IF of 42 to 45 MHz. When Loop 1's output is 250 to 500 MHz, Loop 2's output ranges from 295 to 544 MHz; when Loop 1's output is 500 to 1000 MHz, Loop 2's output ranges from 272 to 522 MHz; and when Loop 1's output is 1000 to 1500 MHz, Loop 2's output ranges from 348 to 515 MHz.

2-28.22 Loop 1 Between 250 and 500 MHz. When the Loop 1 frequency is between 250 and 500 MHz, the multiplication factor to be applied to the Loop 2 signal is unity. Here, the Osc2 control line is at −15 V, turning Q7 on and applying a negative voltage to the cathodes of PIN diodes CR1 and CR2 and to the anodes of CR3 and CR5. CR1 and CR2 are turned on, and CR3 and CR5 are turned off. The signal from Loop 2 appears at the input of amplifier U8, whose output drives the LO port of mixer U6.

2-28.23 Loop 1 Between 500 and 1000 MHz. When the Loop 1 frequency is between 500 and 1000 MHz, the output frequency of Loop 2 must be multiplied by 2. Here, the Osc2 control line is at +15 V, turning Q6 on and applying a positive voltage to the cathodes of CR1 and CR2, and to the anodes of CR3 and CR5. CR1 and CR2 are turned off, and CR3 and CR5 are turned on. The signal from Loop 2 appears at the input of multiplier U5, which doubles the input frequency to produce an output of 544 to 1088 MHz. This signal is amplified by U9, whose output is applied through CR5 to the input of U8.

2-28.24 Loop 1 Between 1000 and 1500 MHz. When the Loop 1 frequency is between 1000 and 1500 MHz, the frequency of Loop 2 must be multiplied by 3. This multiplication is performed within mixer U6, which uses the third harmonic of the Loop 2 signal. Signal switching is the same as for unity multiplication factor.

2-28.25 First Conversion. The 250- to 1500-MHz signal from A7 PC Assembly is buffered by U3, whose output is applied through a pad to the RF input of mixer U6.

2-28.26 The 250- to 1500-MHz signal from Loop 1 is mixed with the output of U8 to produce an IF of 42 to 45 MHz at the IF port of the mixer. This signal is then applied to the input of a 50-MHz lowpass filter.

2-28.27 Second Conversion. The 50-MHz output from Loop 9, which is either a fixed frequency signal derived from A14 PC board, or a frequency modulated signal generated on the A9 PC board, is amplified by U1 and applied to the LO input of mixer U2. The filtered 42- to 45-MHz IF signal is amplified by U26, then applied to the RF input of the mixer, U2. The IF output of U2, a signal between 5 and 8 MHz, passes through a 15-MHz lowpass filter, amplified by Q2, Q1, and Q5, then applied through another lowpass filter and connector J3 to A7. This second IF output is used in phase-locking the Loop 1 oscillator.

2-28.28 Power Supply Filters. U25 contains two complimentary pairs of transistors. These devices are used as beta multipliers to minimize any line-frequency modulation on the instrument's power supplies before their application to critical circuits on the PC board. Considering the +15 V power supply, if the current drawn by the PC board is low, the voltage across R50 will be less than the amount necessary to cause U25-2 to turn on. If the voltage across R50 exceeds about 0.7 V, however, U25-2 turns on, diverting base current from U25-6 and limiting the current supplied to the PC board. The operation of the remaining half of U25 for the −15 V supply is identical.

2-28.29 In order to minimize spurious signals on the instrument's RF output, it is essential to prevent any unintended interaction between the various circuits on the Loop 1 IF PC board. Isolation of the +15 V supplies to the different circuits and effective shielding is essential in achieving this.

2-29. LOOPS 2 AND 9 PC ASSEMBLY A9

2-29.1 This PC board contains the circuitry for Loop 2, which controls the instrument's RF output frequency in 1-MHz steps; Loop 9, which provides frequency modulation; and processing circuitry which scales the FM modulating signal before applying it to the Loop 9 oscillator. Refer to figure 5-34.

2-29.2 Loop 2 (Sheet 2 of 2). Loop 2 generates a 272- to 544-MHz signal which is used to control the instrument's RF output frequency in 1-MHz steps. This signal, in turn, is phase-locked to a 240- to 500-MHz signal from Loop 3, which moves in 20-MHz steps; and to a 25- to 44-MHz signal from Loop 4, which moves in 1-MHz steps.

2-29.3 272- to 544-MHz Voltage-Controlled Oscillator. Varicaps CR5 and CR13, and inductor L3, determine Q2's frequency of oscillation. Q3 buffers the oscillators output, and, in conjunction with U4, increases its level to approximately +8 dBm. The amplifier output is passed through a matching circuit to the inputs of amplifiers U5 and U6.

2-29.4 Loop 2 Output. The output of U6 is applied through a 9-dB pad to J2. This output signal, at nominally +4 dBm, is applied to A8 for use in phase-locking in the Loop 1 oscillators.

2-29.5 Loop 2 Phase Lock Process. A 240- to 500-MHz signal from Loop 3 (on A10), which moves in 20-MHz steps, is applied through J4 to the RF input of mixer U7. The amplified signal from the Loop 2 oscillator is applied to the LO input of the mixer. The mixer's IF output, a frequency between 25 and 44 MHz, passes through a low pass filter to the input of amplifier Q4, Q5. The output of the amplifier is converted to ECL levels by comparator U2 whose output is applied to one input of ECL phase detector U1. The other input to the phase detector is a 25- to 44-MHz signal from Loop 4, located on the A10 PC board. The frequency of this second signal increments in 1-MHz steps.

2-29.6 U1 produces negative-going ECL-compatible output pulses whose widths are proportional to the phase differences between its two input signals. These pulses are amplified and integrated by U3, whose output is proportional to the difference in the pulse widths and thus to the phase error between U1's inputs. U3's output voltage is R13 summed by R13, R14, and R15 with a coarse tune voltage generated on A8 PC Assembly. This combination voltage is then applied to varicaps CR5 and CR13 to control the frequency of the Loop 2 oscillator. This closes the phase-locked loop.

2-29.7 Loop 9 (Sheet 1 of 2). This circuit produces a 100-MHz signal which may be frequency modulated by an audio source. When AC-coupled FM is selected, the 100-MHz VCO is phase locked to a 5-kHz reference signal from A14. The 100-MHz output signal is divided to 50 MHz on A12 and then applied to A8 PC Assembly, where it is used to phase-lock the Loop 1 oscillators. When FM is not selected the 100-MHz VCO is disabled and a 100-MHz signal from A14 PC Assembly, of superior noise performance, is switched to the 100-MHz output of A9 PC Assembly instead.

2-29.8 100 MHz Voltage-Controlled Oscillator. Varicaps CR6, CR7, and inductor L11 determine Q9's frequency of oscillation. Q10 and Q11 switch the oscillator on when it is desired to frequency modulate the instrument's RF output. Q7 buffers the oscillator's output before its application to the switching point.

2-29.9 Switching between 100-MHz Signals. A fixed-frequency 100-MHz signal from A14 PC Assembly is applied through J6 to the input of amplifier U11. When frequency modulation is not selected, the $\overline{\text{FM OSC ON}}$ line is HIGH, turning Q8 off. This permits U11 to amplify the 100-MHz signal from A14 PC Assembly, and U11's output now passes to the input of U9.

2-29.10 When frequency modulation is selected, the $\overline{\text{FM OSC ON}}$ line is LOW. This causes Q8 to turn on, and enables the Loop 9 oscillator. Since Q8 is on, the output of U11 is approximately at ground and the device produces no amplification; additional switches on A14 PC Assembly attenuate the 100-MHz input to U11. The amplified signal from Q9 and Q7 now passes to the input of U9.

2-29.11 100-MHz Output. U9 amplifies the 100-MHz signal at its input to a level of about −2 dBm. The amplifier output is passed through a lowpass filter to connector J5, from which it is applied to divider circuits on A12 PC board.

2-29.12 Loop 9 Phase-Lock Process. The 100-MHz signal from the Loop 9 oscillator is divided by 20,000 on A12 PC Assembly to reduce its frequency to 5 kHz. This signal is then returned to A9 and applied to one input of phase detector U18. The other input to the phase detector is a 5-kHz reference from A14 PC

Assembly. U18 produces positive-going TTL-compatible output pulses whose widths are proportional to the phase differences between its two inputs. These pulses are integrated and amplified by U19-1, whose output is proportional to the difference in the pulse widths at U18's outputs.

2-29.13 U19-1's output voltage passes through a band-reject filter formed by Q16, Q15, Q14, and related components at Q16's base. The filter's output is applied to the input of one section of switch U10. A dc bias of about +7.5 V is applied to the other switch input. When dc-coupled frequency modulation is selected, the dc bias is applied to the summing junction R70, otherwise, the processed phase detector output is present. The voltage at the summing junction is applied to CR6 and CR7 to control the frequency of the Loop 2 oscillator. This closes the loop.

2-29.14 Kicker. When Loop 2 is operating normally, the output of U3-1 is close to 0 V and U3-7 is at −13 V nominal. Under conditions where the input to the phase detector U1 exceed its capability to steer the loop in the correct direction to acquire lock, the output of U3-1 saturates negative. U3-7 comparator output saturates positive forcing U3-1 positive steering the VCO toward the correct lock frequency. U3-7 is reset to −13 V automatically.

2-29.15 Modulation Signal Control. The instrument's RF output signal can be frequency modulated by an internal audio source, by an AC-coupled external source, or by a DC-coupled external source. The instrument's RF frequency is not phase-locked when an external dc source is selected; this feature permits the user to control the instrument's frequency by external processes, when desired.

2-29.16 Modulation Source Selection. Switches U16-15 and U16-10 control the application of the external and internal modulating signals to the input of amplifier U14. Leakage and capacitive coupling through either switch are minimized by grounding the switch output when the associated signal is not selected.

2-29.17 Deviation Scaling. Switches U13-8, U13-9, and the associated resistors and capacitors, form a compensated attenuator circuit which divides the selected modulation signal by 1, 10, or 100 to permit user-selectable deviation sensitivities of 1 MHz/volt, 100 kHz/volt, or 10 kHz/volt.

2-29.18 For RF frequencies of 1500 MHz and above, the input signal is divided by 2 by U13-1. This is necessary as the instrument's basic output frequency is doubled, thus doubling the FM deviation, for RF frequencies in this range. By dividing the audio signal by a factor of two, the deviation on the RF signal remains constant for a given input and selected deviation sensitivity, regardless of RF frequency. The attenuated modulation signal is applied to R71, where it is summed with the signal from the phase detector or dc bias, depending on the state of switch U10.

2-29.19 In AC-coupled FM mode, any small dc offset in the modulating signal, as well as any modulation at a very low audio rate, is removed by the phase-locked loop. The loop bandwidth of 542 nominal sets the lower frequency response link of the system.

2-29.20 Lock Detection. These circuits detect the absence of phase lock in the Loop 2 and Loop 9 oscillators.

2-29.21 Loop 2 Lock Detector. As long as the Loop 2 oscillator is locked to the input from A10 at J3, the outputs of U1 will be at ECL HIGH levels. (In practice, due to noise and time delays within the loop, very narrow pulses are present on the U1-12 output.) However, if the oscillator frequency is not locked to the A10 input, one of the outputs of phase detector U1 will go low. This condition will lower the voltage on the inverting input of comparator U8-7, causing its output, which is applied to interface circuitry on A8, to go LOW. The CPU A15 will detect this status and will instruct A2 to display the appropriate error code on the instrument front panel.

2-29.22 Loop 9 Lock Detection. Operation of this circuit is similar to the lock detector for Loop 2, save that when the Loop 9 oscillator is locked the outputs of phase detector U18 are positive. If the loop becomes unlocked, this status is detected by A15 PC Assembly and transferred to Front Panel Interface A2 PC Assembly which displays the appropriate error code on the instrument front panel. Note that the error code is not displayed when the instrument is programmed for either the CW or DC-coupled FM operating mode, since the Loop 9 oscillator is disabled in such circumstances.

2-29.23 Fault Detection. Since an external modulating signal in excess of 1 V peak can be applied to the instrument, it is necessary to detect the occurrence of such a condition so that the instrument operator may be advised of the situation.

2-29.24 The external FM signal is applied to the inputs of two sections of comparator U15. If this signal exceeds the reference voltage determined by R101 and R102, the output of U15-2 will go to −5 V; and if the signal exceeds the reference voltage determined by R94 and R95 the output of U15-1 will go to −5 V. Either condition will cause the output of U15-13 to go to −5 V, producing 0 V at the anode of CR10. This signal is applied to the A8 PC board.

2-29.25 If an excessive signal is applied, the A15 PC Assembly will instruct the keyboard microprocessor (on A2 PC Assembly) to display the appropriate error code on the instrument front panel, advising the instrument user of the erroneous operating condition.

2-29.26 Power Supply Filters. Transistors Q12, Q13, Q17, Q18, Q19, and Q20 are configured as beta multipliers and current limiters, designed to reduce any line related signals on the instrument power supplies before their application to critical circuits on the A9 PC board. Operation of these circuits is identical to the A7 PC Assembly power supply filters as described in paragraphs 2-27.14 thru 2-27.16.

2-30. LOOPS 3 AND 4 PC ASSEMBLY A10

2-30.1 This PC board produces a 240- to 500-MHz signal from Loop 3, which moves in 20-MHz steps; and, in conjunction with A11 the Divide-by-N, Divide-by-P PC board, a 25- to 44-MHz signal from Loop 4, which moves in 1-MHz steps. These signals are used to control the frequency of Loop 2 on A9. Refer to figure 5-37.

2-30.2 Loop 3 (Sheet 1 of 2). This circuit uses a sampling phase detector which samples and phase-locks the 240 to 500-MHz loop oscillator in 20 MHz increments.

2-30.3 The output of U6 passes through a voltage tuned lowpass filter formed by L4, CR10, and CR11; the purpose of this filter is to reduce the level of the harmonic components which may otherwise cause false-lock to occur. The filter output is split to provide the loop output signal at J6, at a nominal level of −15 dBm, and a signal that is applied to the sampling phase detector.

2-30.4 Impulse Generator. A 20-MHz signal from A14 PC Assembly is applied to J5 and is filtered by crystal filter Y1. After amplification this signal is applied to switching transistor Q1. This transistor is normally off. In this condition step recovery diode CR3 passes forward current and a substantial charge is stored in the device. When the voltage of the applied 20-MHz signal turns on Q1 the step recovery diode becomes reverse biased. When the diode passes from the forward bias state to the reverse bias condition the charge that was stored discharges very rapidly producing a large voltage spike, or impulse, with rise/fall times of less than 1 nsec. This impulse is turned into a differential signal by transformer T1 and coupled via C11 and C10 to sampling diodes CR4 and CR5. When this impulse occurs, diodes CR4 and CR5 conduct and the RF voltage at the junction of these diodes is sampled and transferred to the input to amplifier U2-6. This voltage is stored by the input capacitance of the op-amp until the next sample occurs when the voltage is updated.

2-30.5 Loop 3 Phase-Lock. When the Loop 3 oscillator is phase-locked the output of the phase detector, and U2-6, will be 0 Vdc. Amplifier U3 performs two functions; setting the closed-loop bandwidth and providing a search function for loop acquisition. When the loop is locked the output voltage of U3-6 will be at that dc voltage necessary to maintain a constant phase relationship between the 20-MHz sampling signal and the VCO output, which implies frequency lock at a multiple of the 20-MHz sampling signal.

2-30.6 Loop Acquisition. Should the VCO be off frequency the loop will not be locked. In this event the VCO must be steered to the lock frequency. This is an additional function of the U3-6 circuit. Due to the RC network from pin 6 to positive input pin 3, U3-6 oscillates at approximately 250 Hz when the loop is unlocked. This oscillation causes the VCO frequency to be swept. When the VCO frequency becomes an exact multiple of the 20-MHz sampling signal the loop locks. The effective negative feedback of the phase-locked loop around amplifier U3-6 stabilizes this amplifier and the oscillation of this circuit ceases. The loop is now in a stable, locked condition.

2-30.7 Coarse Tune. The voltage supplied by the Coarse Tune Generator is applied to U7 pin 3. This voltage steers the VCO close to the desired lock frequency and the loop amplifier U3-6 provides the fine tune necessary for phase-lock. The effective tuning range of the U3-6 output is approximately ±10 MHz. If the coarse tune voltage were precisely correct the U3-6 output voltage would be 0 Vdc, since no correction would be required. In reality the U3-6 output voltage will be in the range ±5 Vdc, compensating for the temperature drift of the oscillator and the finite resolution of the digitally generated coarse tuning signal.

2-30.8 VCO Linearization. Due to the voltage versus capacitance characteristics of the varactor diodes the VCO sensitivity, or gain, varies by nearly 10 to 1 over the VCO's range. It is necessary to linearize the VCO for two reasons; firstly, the effective tuning range of amplifier U3-6 must be less than ±20 MHz to avoid locking to the wrong multiple of the 20-MHz sampling signal, while maintaining enough tuning range to compensate for temperature drift; secondly, the loop bandwidth must be held at around 100 to 200 kHz to maintain the required phase noise performance. This linearization is achieved by the switched attenuator circuit of R34, R49, R48, R45, R43, and U8 (the resistor-capacitor networks around these resistors are required to maintain fast tuning to the VCO). Depending on the selected output frequency the appropriate transistors in U8 are turned on maintaining a constant effective VCO gain as seen by amplifier U7-6. Control of the transistor switching is achieved by PROM U10 which is addressed by the frequency data to the board.

2-30.9 Coarse Tune Generator. The Loop 3 frequency data (M data) is applied to PROM U9 address lines. The data in this PROM is customized to the specific board in question, due to the tuning accuracy required. The 8-bit output data is applied to DAC U12 which, in conjunction with op-amp U13-14, generates a voltage which is amplified by U13-8 to provide the required coarse tune voltage. Transistor Q14 is normally off and this voltage is filtered by R61 and C44 to reduce spurious signals on the output. When the loop is required to change frequency Q14 is turned on momentarily to allow fast tuning of the VCO to the new frequency.

2-30.10 Loop 3 Lock Detector. When the loop is unlocked the oscillating signal at the output of U3-6 is rectified and integrated by U5 and associated circuitry, turning Q3 on and applying 0 Vdc to the circle D connector. This informs the A15 PC Assembly of a fault and the appropriate error code (E10.1) appears on the front panel.

2-30.11 Loop 4 (Sheet 2 of 2). Loop 4 produces a 250- to 440-MHz signal with 10-MHz resolution. After division by 10, the 25- to 44-MHz output signal derived therefrom is used to control the frequency of the Loop 2 oscillator (on A9 PC Assembly).

2-30.12 250 to 440 MHz Voltage-Controlled Oscillator. Varicaps CR23 and CR24 and inductor L16 determine the operating frequency of oscillator Q12. Q13 buffers the oscillator output and applies it to amplifier U18. The output of U18 is connected to divider U19, and through a pad to J1, from which it is applied to the Divide-by-N circuit (on A11 PC Assembly).

2-30.13 Divide by 10. U19 divides its 250 to 440 MHz input by 10, producing a 25 to 44 MHz output. This signal is applied through J2 to the Loop 2 phase detector (on A9 PC Assembly).

2-30.14 Loop 4 Phase Lock. The Divide-by-N circuit on A11 PC Assembly divides its input frequency by an integer from 25 to 44 to produce an output at 10 MHz. This signal is sent to J3, where it is applied to the input of ECL phase detector U16, which compares the phase of this signal with that of a fixed 10-MHz reference generated by the A14 PC board.

2-30.15 U16 produces negative-going ECL-compatible output pulses whose widths are proportional to the phase differences between its two input signals. Its outputs are applied to the inputs of two low-noise transistor amplifiers which assist in reducing phase noise. The transistor outputs are applied through lowpass filters to the inputs of integrating amplifier U17-1, whose output is proportional to the difference in the widths of the pulses at U16's outputs and thus to the phase error between the phase detector's inputs. U17-1's output passes through a lowpass filter which provides additional suppression of any 10 MHz components present in the voltage, then drives varicaps CR23 and CR24 to control the frequency of the oscillator. This closes the phase-locked loop.

2-30.16 Linearizer. CR22, R103, and R102 form a linearizer circuit required to maintain a relatively constant loop bandwidth. When the voltage at U17-1 output is low the current through CR22 is high, the diode resistance is low and the attenuation factor is high. When the voltage at U17-1 output is high the opposite applies and the attenuation factor is low.

2-30.17 Loop 4 Lock Detector. As long as the Loop 4 oscillator is locked, the outputs of phase detector U4 will be at ECL HIGH levels. (In practice, due to noise and time delays within the loop, very narrow pulses are present on one or both of U16's outputs.) However, if the oscillator frequency is not locked to the 10-MHz reference frequency, one or both of the phase detector's outputs will be LOW for relatively long periods of time. This condition will lower the voltage on the inverting input of comparator U17-7, causing its output, which is applied to interface circuitry on A8 PC Assembly to go LOW. The A15 PC Assembly will detect this status and will instruct A2 PC Assembly to display the appropriate error code on the instrument front panel.

2-30.18 Power Supply Filters. The transistors in arrays U14 and U15 form beta multipliers which reduce the level of any line-related signals on the instrument's power supplies before their application to critical circuits on the A10 PC board, and limit the current on each supply to 70 mA or less. Q7 and Q8 provide additional filtering for U2 and U3.

2-31. DIVIDE-BY-N AND DIVIDE-BY-P PC ASSEMBLY A11

2-31.1 The A11 PC board contains two programmable divider circuits. The Divide-by-N circuit divides the frequency of Loop 4's 250- to 440-MHz oscillator by an integer between 25 and 44, to produce a 10-MHz output used to phase lock the Loop 4 oscillator. The Divide-by-P circuit divides the frequency of Loop 6's 249.6- to 399.2-MHz oscillator by an integer between 624 and 998, to produce a 400-kHz output used to phase-lock the Loop 6 oscillator. Interface circuitry permits the CPU PC board A15 to program these division ratios. Refer to figure 5-40.

2-31.2 Interface. The interface transfers Control data from the CPU A15 to the A11 PC board, and transfers Status data from A11 to A15.

2-31.3 Address Detection. U6 is a digital comparator whose A=B output (pin 6) is HIGH when the logic levels at its A inputs (pins 10, 12, 13, and 15) are identical to the logic levels at the associated B inputs (pins 9, 11, 14, and 1, respectively).

2-31.4 When the board is addressed and the $\overline{\text{DAV}}$ line is LOW, U7 produces a LOW level at one output determined by address lines A0 through A2; unselected outputs remain HIGH. A LOW at one of U7's Y outputs determines which of four devices (U13, U18, U21, or U22) is selected for data transfer.

2-31.5 Data Transfer. Data transfer direction is determined by the state of the Read/$\overline{\text{Write}}$ line from the CPU PC board A15. When tri-state transceiver U14's DIR line is LOW, transfer is from the instrument data bus to the A11 PC board; when this line is HIGH, transfer is from A11 to the instrument data bus. U14's outputs are enabled by a HIGH at U6's A=B output.

2-31.6 Data is written into latches U13, U21, and U22 when the associated output of U7 moves from HIGH to LOW, the inverters creating a LOW-to-HIGH transition on the Clock input. Note that it is the transition, not the logic state, that causes the latching action.

2-31.7 Latches. Latch U13 holds two BCD digits that control the division ratio of the Divide-by-N circuit which controls the frequency of the Loop 4 oscillator. U21 and U22 hold four BCD digits that control the division ratio of the Divide-by-P circuit which controls the frequency of the Loop 6 oscillator.

2-31.8 Status Information. U18 is a tri-state buffer whose outputs remain in a high-impedance state until its two $\overline{\text{G}}$ lines are low. When this occurs, data on its input pins is transferred to the output pins. If CPU A15 is reading data at that time, U18 will pass the information to the instrument data bus. This permits the CPU to determine the operational status of Loops 5, 6, and 7 and divides N, P, and Q and fixed divide by 20,000.

2-31.9 Divide-by-N. The Divide-by-N circuit divides the 250- to 440-MHz signal from the Loop 4 oscillator on A10 by an integer between 25 and 44 to produce an output of 10 MHz, which in turn is used to lock the Loop 4 oscillator.

2-31.10 Programmable Divider. This divider is of the "pulse swallower" type. Using a prescaler which has two selectable division ratios, a pulse swallower counter permits division by counters which can not operate directly at the input frequency, and makes the presence of the prescaler transparent, i.e. the net division ratio is that of the counters only, not that of the counters multiplied by that of the prescaler.

2-31.11 The major restriction on a counter of this type is that the number programmed into U9 the "coarse" counter must never be less than the number programmed into U3 the "fine" or "swallow" counter. With decimal dividers, the minimum division ratio for this type of counter is usually 90. The circuit here avoids this restriction by the use of a divide-by-5/divide-by-6 prescaler rather than a more conventional divide-by-10/divide-by-11 device. This, however, requires that the dividers' program values do not bear an obvious relationship to the circuit's division ratio.

2-31.12 Division Ratios and Divider Programming. The table below shows the correlation between division ratio and program values.

Division Ratio	Program for U9	Program for U3
25	5	0
26	5	1
27	5	2
28	5	3
29	5	4
30*	6	0
31	6	1
32	6	2
33	6	3
34	6	4
35*	7	0
36*	7	1
37	7	2
38	7	3
39	7	4
40*	7	5
41	8	1
42	8	2
43	8	3
44	8	4

* An allowable alternate program for a division ratio of 30 would be 5,5; for 35, 6,5; for 36, 6,6; and for 40, 8,0.

2-31.13 Divider Operation. U1 divides the frequency of a signal at its input by 5 or by 6, depending on the logic levels at its mode (M) inputs. If both of these inputs are LOW, the device divides by 6; otherwise, it divides by 5.

2-31.14 U3 and U9 are programmable decimal up/down counters. When the S1 input is LOW and a LOW-to-HIGH edge occurs at the CLOCK input (pin 13), the counter is programmed with the number present at the four PRESET inputs, and this value then appears at the four Q outputs. When S1 is HIGH and $\overline{\text{CARRY}}$-in is LOW, the device counts down (from 9 to 8, 8 to 7, etc.).

2-31.15 To understand the operation of this circuit, assume that the counters and flip-flop U11 are in some random state, and that there is an appropriate input present at J1. U1 divides its input by either 5 or 6, depending on the state of its M inputs. If U11 pin 14 is LOW, U3 and U9 will be preset to the numbers on their PRESET inputs upon the first positive transition at their CLOCK inputs. If U11 pin 14 is HIGH, this preset will not occur unless U9 has a count of two at that time due to U10-2.

2-31.16 If the two counters are not immediately preset, U3 will count down until it reaches zero, which causes U10 pin 14 to go HIGH. This will place U1 in the divide-by-5 mode, and, placing U3's $\overline{\text{CARRY}}$-in HIGH, preventing U3 from counting further.

2-31.17 Meanwhile, U9 has also been counting down. When it reaches a count of 2, its Q0, Q2, and Q3 outputs will be LOW. Since U11 pin 14 is HIGH U11 pin 15 is LOW, and U10 pin 2 goes HIGH. On the next positive transition at U11's CLOCK input U9 decrements from a count of 2 to 1 and U11 pin 14 goes LOW; and on the positive transition after that, U3 and U9 will be programmed with the values at the PRESET inputs.

2-31.18 It can be seen from the above that whatever the counters' initial states, they will both end up being preset with the desired values.

2-31.19 Now assume that a division ratio of 37 is desired. This requires that U9 be programmed to 7, and U2 be programmed to 2, as shown in the preceding table. When U11 pin 14 goes LOW and a clock edge then occurs, the counters are preset, and U10 pin 2 goes LOW. On the next positive clock edge, U11 pin 14 goes HIGH and the counters are able to count. Since U3 is not preset to zero, U1's M inputs are LOW and U1 divides by 6.

2-31.20 On successive clock pulses, both U3 and U9 count down, and eventually U3 will reach a count of zero as U9 reaches a count of 5. This results in U1 changing its division ratio from 6 to 5, and the inhibition of further counting by U3, as described above. Further clock edges cause U9 to reach a count of 1, and the following positive clock edge will cause U11 pin 14 to go LOW, creating a preset condition. This completes one cycle.

2-31.21 The table below shows the events of the above example in tabular form.

Input Pulses	Pulses at U1-8	Count in U9	Count in U3	Comments
0	0	7	2	Initial state; U1 divides by 6.
6	1	6	1	First decrement.
12	2	5	0	U3 now inhibited, U1 divides by 5.
17	3	4	0	U9 continues to divide during this period.
22	4	3	0	
27	5	2	0	U11-10 goes HIGH.
32	6	1	0	U11-14 goes LOW; preset will occur on next pulse from U1.
37	7	0 7	0 2	Preset occurs; same as initial state.

2-31.22 U10 pin 3 is HIGH when U11 pin 15 is LOW and U9 has a count other than 2; thus its output is high for 5 times the period of the 250- to 440-MHz input, or 11.3 ns at 400 MHz. The output of U10 pin 3 is applied through J2 to the A10 PC board, where it is used to control the frequency of the Loop 4 oscillator.

2-31.23 Divide-by-P. This circuit divides the 249.6- to 399.2-MHz signal from Loop 6 (on A13) by an integer between 624 and 998, to produce a 400-kHz output which is used to phase-lock the Loop 6 oscillator.

2-31.24 This circuit, like the Divide-by-N circuit above, is a "pulse swallower" type, and operates in substantially identical fashion. The major differences between these two circuits are discussed below.

2-31.25 Prescaler. U31 divides by 11 when both mode inputs are LOW, and by 10 otherwise. Its division ratio is determined by U33 pin 3 in the same manner as is the division ratio of U1 in the Divide-by-N circuit.

2-31.26 Dividers. U30 is a "swallow" counter and operates in the same fashion as does U3. U29 and U28 perform the same function as U9, except that here the division ratio may be as high as 98. Since U28 and U29 are never programmed to a value below 62, there is no need for programming data which is not related to the division ratio. U28 and U29 are cascaded together through their $\overline{\text{CARRY}}$ pins. U29's $\overline{\text{CARRY}}$-out is LOW, allowing U28 to count, only when U29 holds a count of 0. Thus, since the three counters are driven by a common clock, U28 will change state at one-tenth the rate of U29.

2-31.27 When U29 contains a count of two, and U28 contains a count of 9, the preset cycle begins, as described above for the Divide-by-N circuit. Note that U33-9 distinguishes between a count of 0 and a count of 7 in U28.

2-31.28 Provision is made to add U23, another divider, after U28. This device is not used in the Model 1502.

2-31.29 Output Circuits. U34-2 is used as a monostable multivibrator to produce an output pulse suitable for TTL logic. When clocked, its Q output (pin 2) will go HIGH since its D input is HIGH (ground). This HIGH will charge C40, causing the flip-flop's RESET input to go HIGH, which forces the Q output LOW again. The capacitor then discharges.

2-31.30 Q4 converts the ECL signal from U34 to a TTL-compatible signal at its collector. When U34 pin 3 is HIGH, Q4 is off and its collector approaches +5 V. When U34 pin 3 is LOW, Q4 conducts through R15 and its collector approaches 0 V. The transistor's collector is connected to gate U16 and monostable multivibrator U24-4. U24-4 is triggered by the negative-going input and produces a negative-going output pulse about 1 microsecond wide. U16 OR's this pulse with the negative-going pulse from Q4, then applies it to Loop 6 on the A13 PC board.

2-31.31 Fault Detection. Q2 converts the ECL output from U11-3 into a TTL compatible signal which triggers monostable multivibrator U17-13. Due to its construction, this device is retriggerable; as long as a new trigger occurs before the completion of the output pulse caused by the previous trigger, its Q output will remain HIGH. Since these repeated triggers indicate an active Divide-by-P circuit, U17-13 is called an "activity detector". U17-13 has a pulse period of 600 ns; since the normal output frequency of the Divide-by-P circuit is 10 MHz, it is triggered every 100 ns.

2-31.32 U17-5 performs a similar function for the output from U24-4. Here, the "activity detector" has a pulse period of 20 microseconds, and is triggered every 2.5 microseconds.

2-31.33 The output of the two multivibrators are applied to U18 pins 11 and 13, from which they may be read by the CPU.

2-31.34 Power Supplies. Q1 is a beta multiplier which decreases the amplitude of any line-related signals on the instrument's −6.5 V supply prior to its application to critical circuits in the assembly, and reduces the supply voltage to the −5.2 V required by ECL logic.

2-32. DIVIDE-BY-Q PC ASSEMBLY A12

2-32.1 This PC board contains one programmable divider and three fixed dividers. These are used to control the frequencies of the Loop 5, Loop 7, and Loop 1 oscillators. Interface circuitry permits A15 to control the division ratio of the programmable divider. Refer to figure 5-43.

2-32.2 Interface. The interface transfers Control data from the A15 to A12, and transfers Status data from A12 to A15.

2-32.3 Address Detection. U14 is a digital comparator whose A=B output (pin 6) is HIGH when the logic levels at its A inputs (pins 10, 12, 13, and 15) are identical to the logic levels at the associated B inputs (pins 9, 11, 14, and 1, respectively).

2-32.4 When the board is addressed and the $\overline{\text{DAV}}$ line is LOW, U3 produces a LOW level at one output determined by address lines A0 through A2; unselected outputs remain HIGH. A LOW at one of U3's Y outputs determines which of three latches (U17 through U19) is selected for data transfer.

2-32.5 Data Transfer. Data transfer direction is determined by the state of the Read/$\overline{\text{Write}}$ line from A15. When tri-state transceiver U16's DIR line is LOW, transfer is from the instrument data bus to A12; when this line is HIGH, transfer is from A12 to the instrument data bus. U16's outputs are enabled by a HIGH at U14's A=B output.

2-32.6 Data is written into latches U17 through U19 when the associated output of U3 moves from HIGH to LOW, the inverters creating a LOW-to-HIGH transition on the CLOCK input. Note that it is the transition, not the logic state, that causes the latching action.

2-32.7 Latches. Latches U17 through U19 hold five BCD digits which control the division ratio of U5 and U7 through U10, Divide-by-Q.

2-32.8 Divide-by-Q. This circuit divides the 40.000-MHz to 79.995-MHz signal from the Loop 7 oscillator (A13) by an integer from 8,000 to 15,999 to produce an output of 5 kHz which is used to lock the Loop 7 oscillator.

2-32.9 Divider Circuit. This divider is of the "pulse swallower" type, which, by using a prescaler with two division ratios, permits frequencies to be divided by counters which may not be able to operate at those frequencies directly, and makes the presence of the prescaler transparent, i.e. the division ratio is that of the counters only, not that of the counters multiplied by that of the prescaler. The major restriction on a counter of this type is that the number programmed into the "coarse" counters (U5, U9, U8, and U10) may never be less than the number programmed into the "fine" or "swallow" counter U7.

2-32.10 Divider Operation. The 40.000 to 79.995 MHz signal from the Loop 7 oscillator is applied through J3 to the input of prescaler U11, which divides the frequency at its input by either 10 or 11, depending on the logic levels at its M (mode) inputs. If both of these inputs are LOW, the device divides by 11; otherwise, it divides by 10. U11 also contains an interface circuit which generates a TTL-compatible output if it is operated from +5 V rather than −5.2 V.

2-32.11 U6 detects a count of zero in the "swallow" counter U7 and a count of two in the least significant of the "coarse" counters U5. It controls U11's division ratio, setting it to either 10 or 11, as appropriate.

2-32.12 U5 and U7 to U10 are TTL decade up/down counters, used here in the count-down mode. Each counter changes state on the positive-going edge of the clock pulse. To cascade two or more counters of this type, the BORROW output of one counter is connected to the COUNT-DOWN input of the next counter. When the less significant counter contains a 0, its BORROW output goes LOW, going HIGH again when the counter steps from 0 to 9. This positive-going edge, connected to the next counter's COUNT-DOWN input, causes the more significant counter to decrement its count by one.

2-32.13 Assume initially that U5 through U10 are all in some random state, and that an appropriate input is applied to U11. U11 will divide the input frequency by 10 or 11, depending on the state of its M inputs, producing a TTL-compatible output at pin 11. Eventually U7 will reach a count of 0, and U6's Eo output will become HIGH if it wasn't already, placing U11 in the divide-by-10 mode. A continuing input signal will eventually result in a condition where U5, U8, U9, and U10 all contain counts of 0. The BORROW output of U10 will go LOW, bringing the B1 input of U6 HIGH, causing Eo to go HIGH and Fo to go LOW, forcing the counters' Q outputs to immediately conform to the levels present at their PRESET inputs. This causes the circuit to assume the normal initial state.

2-32.14 At the start of the cycle, the five counters are preset to the values presented on their PRESET inputs. U6 pin 7 is LOW and U11 divides by 11 if U7 was not preset to 0. The signal from U11 will cause U7 to count down, eventually reaching a count of 0. When U7's Q outputs are LOW, U6 pin 7 will go HIGH, causing U11 to divide by 10. Logic internal to U6 prevents further activity by U7 from having any effect.

2-32.15 Continuing clock pulses from U6 will cause U5 to decrement from 0 to 9. U6's Q3 output goes HIGH, decrementing U9 by one count. Eventually U9 will count from 0 to 9, generating a BORROW pulse and causing U8 to decrease its count by one. This process repeats until U5, U8, and U10 contains counts of 0, and U9 contains a count of 1.

2-32.16 The next pulse from U11 will cause U5 to count from 0 to 9, causing U9 in turn to count from 1 to 0. As U8 and U10 also contain counts of 0, U10's BORROW output will go LOW, causing a HIGH at U6 pin 10. Further pulses from U11 now cause U5 to continue counting down until it reaches a count of 2. Logic internal to U6 detects this state, and, if U6 pin 10 is HIGH, U6 pin 9 goes LOW, forcing the Q outputs of U5 and U7 to U10 to change to the states at their PRESET inputs.

2-32.17 The next two pulses from U11, which would normally cause U5 to count from 2 to 1, and from 1 to 0, are ignored by U5 due to the presence of a LOW to the PRESET line. A flip-flop internal to U6 now takes over the counting process, ending the PRESET pulse when a count of 0 would normally have been reached. This event also resets U6's zero-count detection circuitry (connected to U7), and sets Eo LOW. This extends the PRESET pulse from a few ns (the counters' propagation delays) to the duration of two clock pulses from U11 (250 ns in the case of an 80 MHz input). This permits the counters to be used at frequencies higher than propagation delays from $\overline{\text{CLOCK}}$ to BORROW and LOAD to Q would otherwise permit.

2-32.18 The negative-going pulse from U6 is applied to U21-3 and to the trigger input of monostable multivibrator U20-4. The multivibrator produces an output pulse 180 s long. The output from U21-3 is used to control the frequency of the Loop 7 oscillator A13.

2-32.19 Fixed Dividers — Divide-by-100. This circuit divides the 40.000- to 79.995-MHz signal from Loop 7 A13 by 100, producing an output of 400.00 to 799.95 kHz which is used to control the frequency of the Loop 5 oscillator on A13.

2-32.20 U12's two M inputs are both HIGH, being pulled up by internal resistors connected to the device's RM1 and RM2 pins. As a consequence, U12 divides the frequency at its input by 10, producing a TTL-compatible output at pin 11. This output is applied to the BD input of TTL divider U22.

2-32.21 U22 divides the frequency at its input by five, producing an 800- to 1599.9-kHz signal at its Qd output, which is further divided by the device's remaining counter, resulting in a 400.00- to 799.95-kHz square wave at its Qa output.

2-32.22 Divide by 20,000. The 100-MHz signal from Loop 9 is amplified by Q4, which produces a TTL-compatible signal at its collector. U13 is a dual JK flip-flop. One half of the device is configured as a T-type flip-flop (i.e. it divides by two), while the other half is unused. The 100 MHz signal from Q4 is applied to the $\overline{\text{CLOCK}}$ input, resulting in a 50-MHz signal at the Q and $\overline{Q}$ outputs.

2-32.23 The signal at U13's Q output is passed through a 50-MHz lowpass filter to J5, after which it is applied to A8, where it is used to control the frequency of the Loop 1 oscillators.

2-32.24 The signal from U13's $\overline{Q}$ output is applied to one of the $\overline{\text{CLOCK}}$ inputs of U25, which, like U13, is a dual JK flip-flop. Both sections of this IC are configured as T-type flip-flops and divide the frequency at their inputs by two, resulting in a 12.5-MHz signal at the U25 pin 9.

2-32.25 U24 and U23 both contain dual bi-quinary (divide-by-2, divide-by-5) dividers. Each IC is configured to divide the frequency at its input by 50, resulting in a total division of 2500. This, in combination with the division by 4 performed by U25, and the division by 2 performed by U13, results in a final division ratio of 20,000. The 5 kHz signal from U23 pin 13 is used to control the frequency of the Loop 9 oscillator on A9 when ac FM is selected.

2-32.26 Divide-by-50. This circuit divides the 250- to 399.999,950-MHz signal from Loop 5 on A13, by 50 resulting in a 5- to 7.999,999-MHz signal used to control the frequencies of the Loop 1 oscillators on A7.

2-32.27 The 250- to 399.999,950-MHz signal from Loop 5 is applied to U1, which divides the frequency by 10 to produce a 25- to 39.999,995-MHz ECL signal at its $\overline{Qn}$ output. This is applied to the clock input of bi-quinary counter U2.

2-32.28 U2 divides the frequency at its input by 5, producing a 5- to 7.999,999-MHz signal at its output (pin 2). This signal is applied through J2 to the Loop 1 PC board A7, where it is used to control the frequencies of the Loop 1 oscillators.

2-32.29 Fault Detection. The 5-kHz signal from U6 pin 9 triggers monostable multivibrator U20-5. Due to its construction, this device is re-triggerable; as long as a new trigger occurs before the end of the output pulse caused by the previous trigger, its Q output will remain HIGH. Since these repeated triggers indicate an active Divide-by-Q circuit, U20-5 is called an "activity detector". U20-5 has a pulse period of 1.7 mS; since the normal output frequency of the Divide-by-P circuit is 5 kHz, it is triggered every 200 microseconds. U26 performs a similar function for the 5 kHz output from U23 pin 3. The pulse period and trigger frequencies are the same as for U20-5.

2-32.30 The output from the multivibrators are applied to the Divide-by-N A11, and P PC board, from which they can be read by the CPU PC board A15.

2-32.31 Power Supply Filters. Q1, Q5 form a beta multiplier which decreases any line-related signals on the instrument's −6.5 V power supply prior to its application to critical circuits in the assembly, and reduces the supply voltage to the −5.2 V required by ECL logic.

2-33. LOOP 5, LOOP 6, AND LOOP 7 PC ASSEMBLY A13

2-33.1 This PC board contains three phase-locked loops. Loop 6 and Loop 7 control the frequency of Loop 5, which in turn is used to control the frequency of the Loop 1 oscillators with 1-Hz resolution. Refer to figure 5-46.

2-33.2 Loop 7 (Sheet 3). This circuit contains a 40.000- to 79.995-MHz oscillator whose frequency is controlled by the A12 PC board. The oscillator output partially determines the frequency of the Loop 5 oscillator: when Loop 7's output frequency changes 5 kHz, the output of Loop 5 changes 50 Hz.

2-33.3 40.000 to 79.995 MHz Voltage-Controlled Oscillator. Varicaps CR11 and CR12, and inductor L20, determine the frequency of operation of oscillator Q18. Q19 buffers the signal from the oscillator and drives amplifier U14, whose output is applied through J3 to the Divide-by-Q circuit on A12. Here, the oscillator frequency is divided by a number between 8,000 and 15,999, then returned to A13.

2-33.4 Phase Lock Process. Phase detector U12 compares the phase of the divided oscillator frequency with that of a fixed 5-kHz reference produced by the Reference Frequency Generator PC board A14. The result of this comparison is used to set the oscillator frequency to an integer multiple of 5 kHz.

2-33.5 If the phases (and therefore frequencies) of U12's inputs are identical, both of its outputs will remain HIGH. Otherwise, one or both of the outputs will produce a negative-going pulse. (In practice, due to noise and unavoidable oscillator drift, one or both of U12's outputs will have very narrow negative-going pulses.)

2-33.6 The phase detector outputs are applied through an RC lowpass filter to the inputs of amplifier U13, whose output is a dc voltage proportional to the phase difference between U12's inputs. U13's output passes through a 5-kHz notch filter and a 10-kHz active low-pass filter formed by Q15, Q16, Q17, and the associated components. The output of the active filter is connected through jumper W4 to the varicaps, closing the phase-locked loop.

2-33.7 Linearizer. When the voltage at the cathode of CR17 is more positive than its anode, which is placed at +2.8 V by R96 and R97, a small change in the tuning voltage will result in a similar change at the varicaps.

2-33.8 However, if the tuning voltage is less than +2.8 V CR17 will begin to conduct, R79 and the parallel combination of R96 and R97 will form a voltage divider. A change in the tuning voltage now results in a smaller change at the varicaps. By proper choice of the various resistor, the frequency-versus-voltage curve of the Loop 7 oscillator can be made sufficiently linear to meet instrument requirements.

2-33.9 Loop 6 (Sheet 2 of 3). This circuit contains a 249.6 to 399.2 MHz oscillator whose frequency is determined by the Divide-by-P circuit on A11. The oscillator output causes the frequency of the Loop 5 oscillator to move in 400-kHz steps.

2-33.10 249.6 to 399.2 MHz Voltage-Controlled Oscillator. Varicaps CR8, CR9, and inductor L19, determine the frequency of operation of oscillator Q9. Q10 buffers the oscillator output and drives amplifier U11, whose output is applied through a pad and connector J2 to the Divide-by-P circuit on A11. Here the oscillator frequency is divided by a number between 624 and 998, then returned to Loop 6.

2-33.11 The output of U11 also passes through a resistive power splitter and is then applied to the RF input of the mixer U15, part of the Loop 5 circuit.

2-33.12 Phase-Lock Process. Phase detector U9 compares the phase of this divided oscillator frequency with that of a fixed 400-kHz reference produced by A14. The phase detector output is used to set the oscillator frequency to an integer multiple of 400 kHz.

2-33.13 If the phases (and therefore frequencies) of U9's inputs are identical, both of its outputs will remain HIGH. Otherwise, one or both of the outputs will produce a negative-going pulse. (In practice, due to noise and unavoidable oscillator drift, one or both of U9's outputs will have very narrow negative-going pulses.)

2-33.14 The outputs of U9 are applied to the inputs of amplifier U10, whose output is a dc voltage proportional to the phase difference between U9's two 400-kHz inputs. This voltage is applied through a 400-kHz lowpass filter and jumper W2 to the varicaps, closing the phase-locked loop.

2-33.15 Coarse Tune Voltage. U10's output voltage is also sent to the Loop 5 oscillator as a "coarse tuning" voltage. As these two oscillators operate at frequencies only 400 to 799.95 kHz apart, this technique eliminates the possibility that the Loop 5 oscillator will lock to an incorrect frequency.

2-33.16 Loop 5 (Sheet 1 of 3). This circuit contains a 250- to 399.999,950-MHz oscillator whose frequency is determined by the Loop 6 and Loop 7 oscillators. The Loop 5 output (after division by 50 on A12) sets the frequency of the Loop 1 oscillators in 1-kHz steps.

2-33.17 250 to 399.999,950 MHz Voltage-Controlled Oscillator. Varicaps CR4, CR5, and inductor L18, determine Q3's frequency of oscillation. Q4 buffers the oscillator output and drives amplifier U5, whose output is connected to amplifier U6 and through a power splitter and pad to connector J1. The signal at J1 is applied to the Divde-by-50 circuit on A12, then applied to A7.

2-33.18 Input From Loop 6 and Frequency Conversion. The output from U6 drives the LO input of mixer U15, whose RF input is driven by the 249.6- to 399.2-MHz signal from the Loop 6 oscillator. This mixer's IF output is the difference between its two frequencies, which, if both oscillators are operating properly, is between 400.000 and 799.95 kHz. (The sum frequency is, of course, also present, but serves no purpose here.)

2-33.19 The IF signal is applied through a low-pass filter to the input of amplifier Q1, Q2 whose output is applied to the input of comparator U8, used as a zero-crossing detector. The comparator's ECL-compatible output is applied to the reference input of ECL phase detector U2-6.

2-33.20 Phase Lock Process. Circuitry on A12 divides the 40.000- to 79.995-MHz signal from Loop 7 by 100 to produce a 400.00- to 799.95-kHz signal with 50 Hz resolution. This signal is converted to ECL-compatible levels by R1, R2 and R4, and then applied to the variable input of the ECL phase detector U2-9.

2-33.21 The 400- to 799.95-kHz inputs from Loop 6 and the mixer U15 are applied to the reference input of ECL phase detector U2-6, which operates similarly to U9 and U12. The phase detector's outputs are applied through RC lowpass filters to the inputs of amplifier U4-1, whose output is a dc voltage proportional to the phase difference between U2's inputs.

2-33.22 The coarse tune voltage from Loop 6 is inverted by U16-1, then applied to the summing input of U16-7. If the output of U16-1 goes negative, clamp CR18 limits its output to about +0.4 V. U16-7's output is applied through a 400-kHz low pass filter to the varicaps. This closes the phase-locked loop.

2-33.23 Kicker. When Loop 5 is operating normally, the output of U4-7 is close to 0 V and U4-1 is at +13 V. Under conditions when the input of the phase detector U2 exceeds its capability to steer the loop in the correct direction to acquire lock, the output of U4-7 saturates positive forcing U4-1 negative steering the VCO toward the correct lock frequency. U4-1 is reset to +13 V automatically.

2-33.24 Lock Detection. These circuits determine the absence of phase-lock in the Loop 5, Loop 6, and Loop 7 oscillators, and, through interface circuitry on the A11 PC board, inform the CPU of the lock status. When the CPU reads the status information from the Divide-by-N and P PC board A11, it will instruct the A2 PC board to display the appropriate error message on the instrument's front panel display.

2-33.25 Loop 5 Lock Detector. R6 and R7 place the inverting input of comparator U3 at −0.91 V. As long as the Loop 5 oscillator is locked to the control frequencies from Loop 6 and Loop 7, phase detector U2's outputs will be at ECL HIGH levels and the voltage on the non-inverting input of comparator U3 will be close to 0 V. The comparator's output will be a TTL HIGH (due to a pullup resistor on the A11 PC board). If the loop is not locked, however, one of U2's outputs will be LOW, and the non-inverting input of the comparator will be at about −1.8 V, and the comparator's output will go LOW.

2-33.26 Loop 6 Lock Detector (Sheet 2). Three sections of resistor network RN4 place the non-inverting input of U10-7 at about +3.3 V. As long as the Loop 6 oscillator is locked, phase detector U9's outputs will be at TTL HIGH levels. Under such conditions the voltage at the inverting input of comparator U10-7 will be close to +5 V. This will cause the output of U10-7 to be at −15 V. CR7 conducts through the leakage resistances of the PC board and the FET gate, placing Q21's gate negative with respect to its source. If leakage currents cause Q21's gate to be at least −2 V, the FET will be off and its drain will be pulled to +5 V by a resistor on the A11 PC board.

2-33.27 However, if the Loop 6 oscillator is not locked, one or both of the phase detector's outputs will be LOW, causing the voltage on the inverting input of U10-7 to be more negative than +3.3 V, and the comparator's output will then approach +15 V. CR6 will cease to conduct, the voltage on the gate of Q21 will be close to the voltage at its source. The FET will now turn on, causing its drain to approach 0 V.

2-33.28 Loop 7 Lock Detector (Sheet 3 of 3). The operation of the Loop 7 lock detector is identical to that of the Loop 6 lock detector, save that U13-7, RN8, CR10, and Q22 are used.

2-33.29 Power Supply Filters. Power supply distribution on this PC board is a critical area, as it is essential to prevent the three oscillators from interacting with each other except as described above. For this reason, the power supplies for each loop are isolated from each other, and from the instrument's power supply buses, by beta multipliers. These beta multipliers also reduce the amplitude of any line-related modulation on the power supply voltages before their application to critical circuits on the PC board.

2-33.30 Q7 (Sheet 1), Q23, and Q13 filter the +6.5 V supply and reduce its level to about +5.0 V for use in Loop 5, Loop 6, and Loop 7, respectively.

2-33.31 Q8 (Sheet 1) filters the −6.5 V supply and reduces its level to about −5.2 V for use in Loop 5.

2-33.32 Q6 (Sheet 1), Q12, and Q14 filter the +17 V supply and reduce its level to about +16 V for use in Loop 5, Loop 6, and Loop 7, respectively.

2-33.33 Q5 (Sheet 1), Q11, and Q20 filter the −17 V supply and reduce its level to about −16 V for use in Loop 5, Loop 6, and Loop 7, respectively.

2-34. REFERENCE FREQUENCY GENERATOR PC ASSEMBLY A14

2-34.1 This assembly produces the various reference frequencies necessary for the operation of the circuits which produce the instrument's RF output. Refer to figure 5-49.

2-34.2 Reference Source Selector (Sheet 1 of 2). This circuit causes the instrument to use an external source as the master reference signal when such a signal is applied.

2-34.3 Internal Reference Selection. The output of the internal 10-MHz source is applied through J7 to pin 13 of NOR gate U18. When no external reference signal is applied, Q14 is normally ON, U18-2 is ECL HIGH, and U12-2 becomes more positive than U12-3; thus, U12-1 is at −5 V and turns off Q15. Q13 conducts which applies a +15 V power supply to the internal 10-MHz oscillator, allowing the oscillator to function.

2-34.4 As U18 is at ECL LOW, the 10-MHz signal passes through to U18-15, to pin 12 of sampler driver U15-4 to introduce a delay at U15-13 relative to U15-12 inputs; thus resulting in a narrow pulse differential output at U15 pins 5 and 9. The two outputs are applied to sampling phase detector circuit.

2-34.5 External Reference Selection. Any external 10-MHz reference present at J6 is applied through C70, R55 to the base of Q14. This signal is amplified by Q14 and applied to U18-4, through U18-2, to CR5 and to pins 6 and 7 of U18. CR5 detects the reference signal and to U12-2 making U12-1 go +5 V, and Q15 conducts. As Q15 collector is at 0 V, N-Channel enhancement-mode field effect transistor Q13 is off.

2-34.6 When Q13 is off, dc power to the internal 10-MHz oscillator is no longer applied and the internal oscillator turns off. U18-13 stays low. The reference signal passes through U18-3 and U18-15.

2-34.7 Oscillator Interactions. If the internal frequency reference were left on when an external reference was used, the two sources would interact to produce a "beat note" in the instrument's RF output frequency, degrading its spectral purity. In order to prevent such interaction, the internal reference is turned off when not in use.

2-34.8 100-MHz Phase-Locked Loop. This circuit creates and controls a 100-MHz signal which is the primary reference signal for the instrument.

2-34.9 100-MHz Oscillator. Crystal Y1, varicap VR1, L8, L9, L10, C47, and C49, determine the frequency of oscillator Q10. The capacitance of the varicap is inversely proportional to the voltage across it (a higher voltage causes less capacitance); thus, the voltage across the diode determines, in part, the oscillator's frequency. The output from the oscillator is applied to Q9, whose output in turn is applied to the input of buffer U9.

2-34.10 100-MHz Buffers and Outputs. The output of U9 has numerous destinations. Its signal is applied through a lowpass filter and pad to J5 for use by A6 PC board; to the input of pin diode switch circuit, through a lowpass filter, to a resistor pad and out to A14J4 for use by A9 PC board; to dividers U5 and U10.

2-34.11 Phase-Lock Process. A portion of the 100-MHz signal from U9 is applied to frequency divider U10 to obtain a 10-MHz signal. This signal is applied to sampling diodes CR2 and CR3 of the sampling phase detector circuit. These diodes conduct whenever the narrow pulses from U15 occur and the RF voltage at the junction of these diodes is sampled, at the same rate as that of internal or external reference signal. This voltage is transferred to the input of amplifier U11-1 and stored by the input capacitance of the op-amp until the next sample occurs when the voltage is updated.

2-34.12 The output from U11-1 is applied to the second amplifier U11-6 which sets the close-loop bandwidth. The output voltage at U11-7 is held at a dc voltage necessary to maintain a constant phase-lock between the divide-by-10 VCO signal and the sampling reference signal. This voltage is applied to varactor diode VR1 that controls the phase of the 100-MHz VCO. This closes the phase lock loop which maintained the oscillator at precisely 100 MHz and is phase controlled by a reference signal.

2-34.13 Reference Frequency Generator (Sheet 2 of 2). This circuit divides the output of the 100-MHz phase-locked oscillator to produce the reference frequencies used throughout the instrument.

2-34.14 ECL 20-MHz Reference. A portion of the 100-MHz output signal from U9 is applied to the input of bi-quinary divider U5, R12, and R13 providing appropriate dc bias. U5 divides the 100-MHz input frequency by 5, producing 20-MHz signals at U5 pins 2, 3, and 4. The signal at pin 4 is ac-coupled through C21 through connector J3 to the comb generator in Loop 3 on the A10 PC board.

2-34.15 ECL 10-MHz Reference. The 20-MHz signal applied to U5 pin 12 is divided by 2, yielding a

10-MHz ECL signal at U5 pin 15. This signal is applied through J2 to the Loop 4 phase detector on the A10 PC board.

2-34.16 TTL References. The 20-MHz ECL output from U5 pin 2 is applied to Q6, creating a TTL-compatible signal at the transistor's collector. Proper circuit operation requires a minimum current gain of 5 at frequencies of 20 MHz. The transistor's output is applied to the "A" (divide-by-2) clock input of TTL bi-quinary divider U1.

2-34.17 U1 divides its 20-MHz input by 2 to produce a 10-MHz output at pin 12. This is applied through a lowpass filter and connector J1 to the two Audio Synthesizer PC boards (A5A1 and A5A2). U1 also produces a 4-MHz output at pin 9 and a 2-MHz output at pin 8.

2-34.18 U4 divides its 2-MHz input by 5 to produce a 400-kHz signal which is buffered by U7, then applied to the Loop 6 phase detector on A13 PC Assembly.

2-34.19 U2 divides its 4-MHz input by 10 to produce a 400-kHz signal at its output. U3 then divides this signal by 16, producing 25 kHz at its output. Finally, U6 divides the 25-kHz signal by 5, producing a 5-kHz output which is buffered by U8 to provide two 5-kHz signals used by the Loop 7 and Loop 9 phase detectors on A13 and A9 PC Assemblies, respectively. The separate divider circuits are needed in order to prevent interaction between the 400-kHz and 5-kHz signals.

2-34.20 100-MHz Switch. This circuit prevents a 100-MHz output signal from J4 when FREQ modulation is required.

2-34.21 When the FM ON control line is LOW, Q18 is off, bringing its collector close to +5 V, turning Q17 on. CR7 is forward biased, attenuating any signal present upon it; CR6 and CR8 are reverse biased, providing maximum attenuation of the signal.

2-34.22 External 10-MHz Output. This 10-MHz signal from U10 is AC-coupled by C92. This signal is converted to a TTL compatible signal, by the voltage divider R83 and R84, and is applied to Positive-NAND 50-ohm line driver U19, whose output is applied to the instrument's rear panel 10-MHz output connector.

2-34.23 Fault Detectors. These circuits detect the absence of phase-lock in the 100-MHz oscillator and the absence of a 10-MHz reference input. Through interface circuitry on the A3 PC board, the CPU can detect such occurrences and act accordingly.

2-34-24 Lock Detector. Comparators U13 and U14 have open-collector outputs. R51, R52, and R53 form a voltage divider which places +1 V at the inverting input of U13, and +9.5 V at the non-inverting input of U14. The control voltage for the 100-MHz oscillator is applied to the remaining inputs of these comparators by R43. It is assumed that the 100-MHz oscillator is locked if the tuning voltage remains within these limits; under such conditions both comparator outputs are off. If the oscillator is not locked to the reference, the tuning voltage will exceed one of these limits, causing the appropriate comparator to turn on.

2-34.25 Missing Reference Detector. The 10-MHz output from U15 pin 11 is detected by CR1 and CR2. Normal circuit operation exists if the amplitude of the 10-MHz signal is adequate to maintain Q19 off, thus maintaining the emitter of the transistor more positive than +2 V. If the signal amplitude is too low, Q19 will turn on, and the 10-MHz status line will be LOW.

2-34.26 Current Limiters. Transistor arrays U16 and U17 form four current limiters which are intended to prevent damage to A14. As all of these circuits are identical, only one, the +6.5 V limiter, will be discussed.

2-34.27 As long as the current through R79 is less than about 70 mA the voltage across the resistor will not be sufficient to turn on U16-2, and U16-6 will act as a beta multiplier, removing any line-related modulation on the power supply before its application to critical circuits on the PC board. If, however, the current through resistor R79 causes U16-2 to conduct, the base bias of U16-6 will be diverted through U16-2, causing the circuit's output to decrease. Selection of R78 permits the circuit's output voltage to be set to +5.0 V.

2-35. CPU PC ASSEMBLY A15

2-35.1 The CPU PC board controls the entire instrument except for the front panel keyboard and display circuitry. It permits the instrument to be operated by an external controller through a standard IEEE-488 1978 interface. Refer to figure 5-52.

2-35.2 Power-On Reset. Timer U3, in conjunction with inverter U4-12, provides a power-on reset function for the microprocessor and its supporting circuitry. Switch S1 (not accessible from the front panel) provides a manual reset capability for troubleshooting, if required.

2-35.3 Clock Generator. U2 creates a 4-MHz TTL-compatible signal used as the main microprocessor clock.

2-35.4 Main Microprocessor. U5 is an 8-bit microprocessor circuit which is responsible for producing all of the control data required by the instrument's signal-generating and signal-controlling circuitry. It converts level, frequency, and modulation data from the keyboard microprocessor on A2 PC Assembly into setpoint and control information required by the various PC boards.

2-35.5 Memory I/O and Peripheral Device Selection. Device selection is controlled by two 1-of-8 decoders. U1 selects RAM, Timer, IEEE-488 and instrument bus devices, and U13 selects the instrument specific and control software EPROMs.

2-35.6 Random-Access Memory ($00XX). U9 is a memory device capable of storing 2 kilobytes of transient data.

2-35.7 Interrupt Timer ($28XX). U25 is a programmable timer which produces non-maskable interrupt requests at intervals determined by the microprocessor.

2-35.8 Instrument Bus ($30XX). Communication with the instrument's signal-generating and signal-controlling circuitry is by an 8-bit bi-directional data bus and an 8-bit address bus. The intercommunication with the Front Panel Interface PC board A2 also takes place through this bus. Data transfer on this bus is controlled by the DAV and Read/Write control lines.

2-35.9 U22 is a dual D-type flip-flop which produces a positive-going pulse shortly after $30XX goes LOW and the Enable line from microprocessor U5 is HIGH.

2-35.10 U20 is a bi-directional transceiver. The direction of data transfer is controlled by the R/W signal from U4-2. The state of U20's outputs is determined by the logic level at pin 19 of the device. This line is HIGH when the microprocessor is neither reading data from, nor writing data to, the instrument bus. During these periods, U20 is in its high-impedance state.

2-35.11 Latch U19 buffers the 8-bit instrument address bus. Address Data is transferred to the latch outputs when $30XX is low and the Enable line from microprocessor U5 is HIGH.

2-35.12 IEEE-488 Interface Circuits ($38XX). U26 is a device designed to perform the majority of the interface and handshake requirements of the IEEE-488 interface protocol. U11 and U27 are transceivers which possess the electrical characteristics required by the interface specification. These two devices directly drive the interface bus.

2-35.13 Instrument-Specific Read-Only Memories ($08XX, $4XXX). U10 and U12 are 2-kilobyte programmable read-only memories in which U10 stores a data table describing variations in the instrument's RF output as a function of frequency and attenuator step, and U12 stores data tables of the Loop 1 and Loop 2 Coarse Tune Voltages as a function of the loop's frequency.

2-35.14 Program Storage Read-Only Memory ($8XXX-EXXX). U6, U7, and U8 are 8-kilobyte programmable devices which store U5's control software.

2-36. POWER SUPPLY PC ASSEMBLY A16

2-36.1 The Power Supply PC board and related components convert the ac power line voltage to produce the regulated voltages needed for instrument operation. For the sake of clarity and convenience in this discussion, all related components are considered as part of this assembly, whether or not mounted on the A16 PC board. Refer to figure 5-54.

2-36.2 AC Line Components. These convert the voltage of the standard ac power line to various lower voltages compatible with the desired dc outputs.

2-36.3 AC Line Selector Filter and Fuse. AC line filter FL1 provides a chassis-mounted plug suitable for use with the instrument's power cord. It contains an integral filter which suppresses spurious signals and transients on the power lines which might affect the instrument, as well as any spurious signals generated by the instrument which might otherwise be coupled into the ac power lines.

2-36.4 The line filter also provides the user with a means to adapt the instrument for several common ac line voltages. A programming card within the line filter connects power transformer T1's primary windings as appropriate for a 100, 115, or 230 V ac power line voltage. For operation with 100 and 115 V ac lines T1's primary windings are placed in parallel, while in the 230 V position they are placed in series.

2-36.5 Finally, the line filter assembly contains a fuse F1 to protect the instrument from damage due to excessive voltages on the ac power line and from instrument faults which would cause it to draw abnormally high current levels. This fuse also provides some measure of safety protection in the case of accidental contact with the line voltage by personnel working on or with the instrument. AC line voltage is present whenever the instrument is connected to the ac line, regardless of the state of the AC POWER switch.

2-36.6 Power Transformer. Main power transformer T1 generates the raw ac voltages required by the instrument. This transformer has two primary windings and four secondary windings. One primary winding is tapped for 100 and 115 V operation. Placing the primary windings in parallel configures the transformer for a 100 or 115 V ac line while placing them in series, configures the transformer for a 230/240 V ac line.

2-36.7 Unregulated Supplies. This group of circuits rectifies the ac output voltages from the power transformer and filters these raw supplies to produce dc voltages suitable for use by the regulators.

2-36.8 Unregulated power supply voltages are present whenever the instrument is connected to the ac power line regardless of the state of the AC POWER switch.

2-36.9 Secondary #1. This center-tapped transformer winding produces about 8.8 V rms. This voltage is rectified by diode bridge U11 and filtered by A24C1 and A24C2 to produce +10 V. This voltage is regulated to provide the instrument's +5 V supply. R25 provides a load for the supply when the instrument is in the STANDBY mode.

2-36.10 Secondary #2. This center-tapped transformer winding produces about 9.8 V rms. This voltage is rectified by diode bridge U12 and filtered by C7 and A24C11 to produce +12 V and −11 V. These voltages are regulated to provide the instrument's +6.5 and −6.5 V supplies. R20 and A24R24 provide loads for these supplies when the instrument is in the STANDBY mode.

2-36.11 Secondary #3. This center-tapped transformer winding produces about 20 V rms. This voltage is rectified by diode bridge U13 and filtered by C15 and C22 to produce +26 V and −26 V. These voltages are regulated to provide the instrument's +17 and −17 V supplies, a variable-voltage supply which powers the instrument's cooling fan, and the supply for standby relay K1. R21, and R22 provide loads for these supplies when the instrument is in the STANDBY mode.

2-36.12 Secondary #4. This transformer winding produces about 27 V rms. This voltage is rectified by diode bridge U14 and filtered by C29 to produce +35 V. This voltage is regulated to provide the instrument's +26 V supply. R23 provides a load for the supply when the instrument is in the STBY mode.

2-36.13 Standby Relay and Power Switching. Standby relay K1 controls the application of dc power to the instrument's various regulators. When the front-panel POWER switch is placed in the ON position, the relay applies the outputs of the various rectifiers to the instrument's voltage regulators. When the switch is in the STBY position the relay is not energized and voltage is applied only to the oscillator power supply regulator (U10). This permits the optional temperature stabilized crystal oscillator to reach its specified accuracy and stability almost immediately after the instrument is turned ON.

2-36.14 Voltage Regulators. These circuits regulate the voltages from the rectifiers and filter capacitors to produce nine power supply voltages.

2-36.15 +15 V Oscillator Regulator. U10 is a fixed-output regulator IC which produces +15 V +5% between its output (pin 3) and common (pin 2) terminals. C33 and C34 provide transient suppression for this regulator.

2-36.16 +5 V Regulator. U1 requires a 1.25 V difference between its output (pin 3) and adjustment (pin 1) terminals, and will vary its output voltage as necessary to create such a condition. The voltage across R1 determines the current through the resistor. As the adjustment terminal neither sinks nor sources significant current, the current through R2 is substantially the same as that through R1. The voltage drop across R1 and R2 therefore sets the voltage between U1's output terminal and ground. C3, C4, and C5 provide bypassing and transient suppression.

2-36.17 Other Regulators. All of these operate in the same general fashion as the +5 V regulator. The resistor between the output and adjustment terminals, and the resistor between the adjustment terminal and ground, determines the regulator's output voltage in each case.

2-36.18 Fan Control System. This circuit controls the speed of the instrument's cooling fan in order to minimize temperature variations and moisture condensation within the instrument. Cooling is minimized at temperatures below 25°C and reaches maximum at 35°C.

2-36.19 Application of power to this circuit is controlled by K1. The +Ve voltage output from bridge rectifier U12 and the −Ve voltage output from bridge rectifier U13 are applied to negative regulator U2. The regulator creates 1.25 V between its output terminal (pin 3) and adjustment terminal (pin 1). The resistance of R3 varies as a function of temperature, becoming less as temperature increases; therefore, the current flowing through the resistor also varies as a function of temperature. The output voltage of the regulator depends on the voltage developed across R4; since this voltage is determined by the current through R3, the circuit's output voltage increases as the temperature increases. As the speed of the instrument's fan depends on the voltage applied to it, becoming greater as the voltage increases, the fan's speed will also change as a function of temperature.

2-36.20 Diodes CR1 through CR4 limit the regulator output voltage range from between 20 V and 28 V to ensure the cooling fan is never turned off or overdriven.

2-37. OUTPUT MODULE

2-37.1 This assembly consists of Output Module Section 2 Assembly A22, which does most of the RF signal processing, and Output Module Section 1 Assembly A23, which does the switching functions, level detection and power supply regulation and filtering. For Model 1501, refer to figure 5-58. For Model 1502, refer to figure 5-61.

2-37.2 Control Signals. Control signals for the operation of this assembly originate with instructions generated by A15 PC board, and are processed by A3 PC board and A23 PC board.

2-37.3 Signal Processing Circuits — 250 to 1500 MHz. The 250 to 1500 MHz output from A7 PC board is applied through connector J1 to the input of Leveler/Amplifier A22A1 which amplifies or attenuates the signal applied to its input, through A22A2 Pulse Modulator, through J3 of HF Switch A22A3, and to J1 of A23A1 for harmonic filtering and amplification.

2-37.4 100 kHz to 250 MHz. When frequencies below 250 MHz are selected, the signal from the HF Switch A22A3, which frequency is from 800.1 MHz to 1049.999 999 MHz, is switched through J2 to the Downconverter PC board A6.

2-37.5 1500 MHz to 2500 MHz. Frequency doubler A22A4 converts its 750- to 1250-MHz input to a 1500- to 2500-MHz output at a power level of about 0 dBm. This signal is amplified by A22A5 to a level of +13 dBm, then applied to the input of switch A22A6. The switch applies its input to one of the bandpass filters A22A7 or A22A8. These filters operate from 1500 to 1900 MHz, and from 1900 to 2500 MHz. The output from the appropriate filter is selected by switch A22A9, then applied to the input of PIN leveler A22A10.

2-37.6 Leveling. PIN leveler A22A10 varies its attenuation of the signal applied to its input in accordance with a control voltage from the Level Control PC board A4. This control voltage is used to adjust the instrument's RF output; the more positive the voltage, the less attenuation presented by the leveler. The output from A22A10 is applied to amplifier A22A11, which produces a maximum output of at least +23 dBm. This output is applied through J2 to Output Module Section 1 Assembly A23.

2-37.7 Step Attenuator A22A12. This device attenuates the level of the RF signal applied to it from the Level Detector A23A4 module on A23 PC Assembly in 10-dB steps. Its output is the instrument's RF output, which is an N-type connector.

2-37.8 The step attenuator also incorporates a relay and detector diode used to protect the instrument from the application of RF power from external sources. The operation of these components is discussed in the theory of operation of the Output Module Section 1 Assembly A23.

2-38. OUTPUT MODULE SECTION 1 ASSEMBLY A23

2-38.1 The Output Module Section 1 Assembly A23 consists of a printed circuit board and three RF modules. It switches on the appropriate bandpass filter and selects the 0.100 to 250 MHz signal from A6 PC board, the 250 to 1500 MHz RF signal produced on A7 PC board, or the 1500 to 2500 MHz signal created on Output Module Section 2 Assembly A22, detects the amplitude of the selected signal, applies the selected signal to the instrument's RF step attenuator A22A12, and processes the detected signal for use by A4 PC board. Finally it controls the operation of the reverse power protection relay within the RF step attenuator. For Model 1501, refer to figure 5-64. For Model 1502, refer to figure 5-66.

2-38.2 RF Signal Section — 0.100 to 250 MHz Signal Path. The 0.100 to 250 MHz output from the Downconverter is applied to connector J9 of A23A1, passes through A23A3, and is then applied to the input of level detector A23A4.

2-38.3 The 250 to 1500 MHz from J3 of HF Switch A22A3 is applied to one of the four bandpass filters, for harmonics suppression, in A23A1 Filter/Amplifier module. The appropriate filter is selected for frequency bands 250 to 400 MHz, 400 to 650 MHz, 650 to 1000 MHz, and 1000 to 1500 MHz. The filtered RF signal is then amplified and applied through the HF Switch A23A3 and to A23A4 module for level detection.

2-38.4 1500- to 2500-MHz Signal Path. When frequencies above 1500 MHz is selected, the signal from A22A3 is applied to Frequency Doubler A22A4 to produce a signal of 1500 to 2500 MHz. The signal is amplified in two stages by Amplifier Module A22A5 and through HF Switch A22A6 that selects the 1500 to 1900 MHz or the 1900 to 2500 MHz bandpass filter. The filtered output is switched through A22A9 and to Leveler A22A10. The Leveler's output level is controlled by the voltage applied to J3 from the Level Control PC board A4. A negative control voltage to the leveler will result to maximum signal attenuation and about +5 V for minimum attenuation. The signal from the Leveler is applied to Amplifier A22A11, to produce a minimum signal level of +23 dBm at minimum leveler attenuation, through A23A1-J8 and to HF Switch A23A3.

2-38.5 Output Selection. RF switch A23A3 selects one of the three outputs (two outputs for Model 1501) from A23A1. The selected signal passes through detector module A23A4 and then is applied to the instrument's step attenuator on A22 (A22A12). The attenuator's output appears at the instrument's RF output connector.

2-38.6 Level Detection. The level of the RF signal selected by A23A3 is sensed by a detector diode within A23A4. Additional circuitry adjusts the gain and dc offset of the detector output to permit calibration of the instrument's RF output level. The circuit output is applied to the Level Control PC board A4.

2-38.7 Reference Voltage Generator. The Output Module Section 1 Assembly A23 uses an integrated voltage reference U9 to produce highly stable +10.00 V from a regulated +15 V supply. To generate a negative reference voltage, the +10.00 V reference is applied to the inverting input of amplifier U15, with a gain of 1 due to the ratio of R95/R94, producing a −10.00 V at U15-7 output.

2-38.8 Signal Processing. The +10.0 V reference applied to R89 and R90 causes a fixed bias current in the two diodes within A23A4. If no RF voltage is applied to the detector, the outputs of the two diodes will be identical, the outputs of buffers U12-1 and U12-7 will be equal, and the output of differential amplifier U14 will be 0 V. If an RF signal is present, the output from the detector diode will go negative, causing U14's output to go positive. U14's output, which is proportional to the RF voltage present on the detector is applied to the input of U14-5 of the detector linearizer circuit. This circuit is critical to AM performance at low RF power levels. R97 is provided to optimize AM distortion and the symmetry of the AM envelope at the minimum vernier level of −2.9 dBm.

2-38.9 The output of U14-7 is applied to U15-2, where the gain of this stage is adjusted by R77 and an offset adjustment R71. U15-1 output goes through J5 to Level Control PC board A4.

2-38.10 Detector Time Constants. The response of any detector circuit is determined by the impedance voltage drop across R1 and R2 therefore sets the voltage between U1's output terminal and ground. C3, C4, and C5 provide bypassing and transient suppression.

2-36.17 Other Regulators. All of these operate in the same general fashion as the +5 V regulator. The resistor between the output and adjustment terminals, and the resistor between the adjustment terminal and ground, determines the regulator's output voltage in each case.

2-36.18 Fan Control System. This circuit controls the speed of the instrument's cooling fan in order to minimize temperature variations and moisture condensation within the instrument. Cooling is minimized at temperatures below 25°C and reaches maximum at 35°C.

2-36.19 Application of power to this circuit is controlled by K1. The +Ve voltage output from bridge rectifier U12 and the −Ve voltage output from bridge rectifier U13 are applied to negative regulator U2. The regulator creates 1.25 V between its output terminal (pin 3) and adjustment terminal (pin 1). The resistance of R3 varies as a function of temperature, becoming less as temperature increases; therefore, the current flowing through the resistor also varies as a function of temperature. The output voltage of the regulator depends on the voltage developed across R4; since this voltage is determined by the current through R3, the circuit's output voltage increases as the temperature increases. As the speed of the instrument's fan depends on the voltage applied to it, becoming greater as the voltage increases, the fan's speed will also change as a function of temperature.

2-36.20 Diodes CR1 through CR4 limit the regulator output voltage range from between 20 V and 28 V to ensure the cooling fan is never turned off or overdriven.

2-37. OUTPUT MODULE

2-37.1 This assembly consists of Output Module Section 2 Assembly A22, which does most of the RF signal processing, and Output Module Section 1 Assembly A23, which does the switching functions, level detection and power supply regulation and filtering. For Model 1501, refer to figure 5-58. For Model 1502, refer to figure 5-61.

2-37.2 Control Signals. Control signals for the operation of this assembly originate with instructions generated by A15 PC board, and are processed by A3 PC board and A23 PC board.

2-37.3 Signal Processing Circuits — 250 to 1500 MHz. The 250 to 1500 MHz output from A7 PC board is applied through connector J1 to the input of Leveler/Amplifier A22A1 which amplifies or attenuates the signal applied to its input, through A22A2 Pulse Modulator, through J3 of HF Switch A22A3, and to J1 of A23A1 for harmonic filtering and amplification.

2-37.4 100 kHz to 250 MHz. When frequencies below 250 MHz are selected, the signal from the HF Switch A22A3, which frequency is from 800.1 MHz to 1049.999 999 MHz, is switched through J2 to the Downconverter PC board A6.

2-37.5 1500 MHz to 2500 MHz. Frequency doubler A22A4 converts its 750- to 1250-MHz input to a 1500- to 2500-MHz output at a power level of about 0 dBm. This signal is amplified by A22A5 to a level of +13 dBm, then applied to the input of switch A22A6. The switch applies its input to one of the bandpass filters A22A7 or A22A8. These filters operate from 1500 to 1900 MHz, and from 1900 to 2500 MHz. The output from the appropriate filter is selected by switch A22A9, then applied to the input of PIN leveler A22A10.

2-37.6 Leveling. PIN leveler A22A10 varies its attenuation of the signal applied to its input in accordance with a control voltage from the Level Control PC board A4. This control voltage is used to adjust the instrument's RF output; the more positive the voltage, the less attenuation presented by the leveler. The output from A22A10 is applied to amplifier A22A11, which produces a maximum output of at least +23 dBm. This output is applied through J2 to Output Module Section 1 Assembly A23.

2-37.7 Step Attenuator A22A12. This device attenuates the level of the RF signal applied to it from the Level Detector A23A4 module on A23 PC Assembly in 10-dB steps. Its output is the instrument's RF output, which is an N-type connector.

2-37.8 The step attenuator also incorporates a relay and detector diode used to protect the instrument from the application of RF power from external sources. The operation of these components is discussed in the theory of operation of the Output Module Section 1 Assembly A23.

2-38. OUTPUT MODULE SECTION 1 ASSEMBLY A23

2-38.1 The Output Module Section 1 Assembly A23 consists of a printed circuit board and three RF modules. It switches on the appropriate bandpass filter and selects the 0.100 to 250 MHz signal from A6 PC board, the 250 to 1500 MHz RF signal produced on A7 PC board, or the 1500 to 2500 MHz signal created on Output Module Section 2 Assembly A22, detects the amplitude of the selected signal, applies the selected signal to the instrument's RF step attenuator A22A12, and processes the detected signal for use by A4 PC board. Finally it controls the operation of the reverse power protection relay within the RF step attenuator. For Model 1501, refer to figure 5-64. For Model 1502, refer to figure 5-66.

2-38.2 RF Signal Section — 0.100 to 250 MHz Signal Path. The 0.100 to 250 MHz output from the Downconverter is applied to connector J9 of A23A1, passes through A23A3, and is then applied to the input of level detector A23A4.

2-38.3 The 250 to 1500 MHz from J3 of HF Switch A22A3 is applied to one of the four bandpass filters, for harmonics suppression, in A23A1 Filter/Amplifier module. The appropriate filter is selected for frequency bands 250 to 400 MHz, 400 to 650 MHz, 650 to 1000 MHz, and 1000 to 1500 MHz. The filtered RF signal is then amplified and applied through the HF Switch A23A3 and to A23A4 module for level detection.

2-38.4 1500- to 2500-MHz Signal Path. When frequencies above 1500 MHz is selected, the signal from A22A3 is applied to Frequency Doubler A22A4 to produce a signal of 1500 to 2500 MHz. The signal is amplified in two stages by Amplifier Module A22A5 and through HF Switch A22A6 that selects the 1500 to 1900 MHz or the 1900 to 2500 MHz bandpass filter. The filtered output is switched through A22A9 and to Leveler A22A10. The Leveler's output level is controlled by the voltage applied to J3 from the Level Control PC board A4. A negative control voltage to the leveler will result to maximum signal attenuation and about +5 V for minimum attenuation. The signal from the Leveler is applied to Amplifier A22A11, to produce a minimum signal level of +23 dBm at minimum leveler attenuation, through A23A1-J8 and to HF Switch A23A3.

2-38.5 Output Selection. RF switch A23A3 selects one of the three outputs (two outputs for Model 1501) from A23A1. The selected signal passes through detector module A23A4 and then is applied to the instrument's step attenuator on A22 (A22A12). The attenuator's output appears at the instrument's RF output connector.

2-38.6 Level Detection. The level of the RF signal selected by A23A3 is sensed by a detector diode within A23A4. Additional circuitry adjusts the gain and dc offset of the detector output to permit calibration of the instrument's RF output level. The circuit output is applied to the Level Control PC board A4.

2-38.7 Reference Voltage Generator. The Output Module Section 1 Assembly A23 uses an integrated voltage reference U9 to produce highly stable +10.00 V from a regulated +15 V supply. To generate a negative reference voltage, the +10.00 V reference is applied to the inverting input of amplifier U15, with a gain of 1 due to the ratio of R95/R94, producing a −10.00 V at U15-7 output.

2-38.8 Signal Processing. The +10.0 V reference applied to R89 and R90 causes a fixed bias current in the two diodes within A23A4. If no RF voltage is applied to the detector, the outputs of the two diodes will be identical, the outputs of buffers U12-1 and U12-7 will be equal, and the output of differential amplifier U14 will be 0 V. If an RF signal is present, the output from the detector diode will go negative, causing U14's output to go positive. U14's output, which is proportional to the RF voltage present on the detector is applied to the input of U14-5 of the detector linearizer circuit. This circuit is critical to AM performance at low RF power levels. R97 is provided to optimize AM distortion and the symmetry of the AM envelope at the minimum vernier level of −2.9 dBm.

2-38.9 The output of U14-7 is applied to U15-2, where the gain of this stage is adjusted by R77 and an offset adjustment R71. U15-1 output goes through J5 to Level Control PC board A4.

2-38.10 Detector Time Constants. The response of any detector circuit is determined by the impedance of the RF source, the impedance of the detector, the charge storage capacitor at the detector's output, and the current drawn by any load on that capacitor. For a detector to respond properly to low RF frequencies the capacitor must be relatively large; however, this capacitor must be small enough that no significant distortion of the RF signal's modulation envelope is introduced.

2-38.11 For optimum RF leveling, U13 switches additional capacitors into the detector circuit when low frequency RF signals are selected. This provides adequate rejection of low-frequency RF signals; and, when these capacitors are switched out of the circuit, permits pulse modulation and a higher AM bandwidth over most of the instrument's RF frequency range.

2-38.12 Control Switches. The Interface PC board A3 provides latched control lines which determine all signal selection and switching on both Output Module Sections A22 and A23. The CPU PC board A15 determines which of these lines are HIGH and which are LOW, depending on the RF output frequency.

2-38.13 Detector Time Constant Selection. The A3 PC board provides two detector time constant control lines which are applied to U13, a dual differential amplifier. When a control line is LOW, the associated A13 output is +V, the series and shunt diodes are reverse biased, and the capacitor is not in the circuit. When the control line is high the associated diodes are forward biased as A13 output goes −V and the capacitor is connected to ground through the shunt diode CR19 or CR20.

2-38.14 250- to 1500-MHz Filter Selection. The Interface PC board A3 provides four bi-polar control lines which are applied to the gates of FETs Q1 to Q4. When a control line is at −17 V the associated FET is off and its drain is at +15 V, turning off the pair of switches within the RF module. When the control line is at +17 V the FET conducts, causing a current of at least 30 mA to flow through the switch pair, turning them on.

2-38.15 Control of A23A3. The Interface PC board A3 provides three bi-polar control lines which are applied to the bases of pairs of complimentary transistors within arrays U3 and U4. These voltages are buffered by the transistors, whose outputs drive the associated PIN diodes in RF switch A23A3, thus determining which RF signal is applied to the instrument's RF output connector.

2-38.16 Switching Functions for Output Module Section 2 Assembly A22. The Interface PC board A3 provides five bi-polar control lines which are applied to the bases of pairs of complimentary transistors within arrays U1 through U4. These voltages are buffered by the transistors, whose outputs drive RF switches A22A3, A22A6, and A22A9, controlling the switching of the 250 to 1500 MHz signal from the Pulse Modulator A22A2 and filter selection of Bandpass Filters A22A7 and A22A8.

2-38.17 Attenuator Drivers. The six attenuation control relays in the step attenuator have a common negative terminal. Each relay is energized when +12 V is applied to its free end.

2-38.18 The Interface PC board A3 provides six open-collector outputs from relay driver A3U20. When the transistor in the relay driver is off, the associated transistor in U5 or U6 is also off and no current flows through it; the relay is not energized, and that attenuator section presents minimum attenuation to the RF signal. When the transistor in the relay driver is on, the transistor in U5 or U6 turns on; the relay energizes, and the selected attenuator selection provides significant attenuation (e.g. 10 or 20 dB) to the RF signal. R44 through R50, limit the voltage applied to the relay to +15 V.

2-38.19 Reverse Power Protection. The RF step attenuator A22U1 contains a detector diode at its output. The detector output is connected across R5 and C17 to the non-inverting input of comparator U10-1.

2-38.20 When no reverse power is applied to the instrument, the RF level at the attenuator output is relatively low, the detector diode produces a small output voltage, and U10-1's output is positive. CR1 is reverse biased and U10-7's output is positive, causing FET Q5 to conduct, which in turn energizes a relay at the output of the step attenuator, permitting an RF output to appear at the instrument's output connector. The anode of CR2 is tied to +5 V by a resistor on the Interface PC board A3, thus this diode is reverse biased. This is the normal state of affairs.

2-38.21 If an RF signal of several watts is applied to the instrument's RF output, the detector output exceeds about −6 V and the U10-1's output goes negative, causing CR1 to conduct and the output of U10-7 to go negative, turning Q5 off. This removes the reverse power relay drive to A22A12, thus isolating the instruments RF output circuitry from the RF output connector. CR2 and CR3 are forward biased, placing the anode of CR2 at ground. This creates a TTL-compatible LOW on the input of A3U21. When the CPU PC board A15 reads the data on A3U21, it will transfer this data to A2 PC board which in turn will display the appropriate error code.

2-38.22 If the RF power applied to the instrument's input is removed, the output of U10-1 will again go positive. C17 will discharge, causing the output of U10-7 to return to its initial state, and instrument's RF output will again appear at the RF output connector.

2-38.23 Power Supplies — Filters and Limiters for A23. Transistor array U8 is configured as combination beta multipliers and current limiters. As each configuration is identical to the others, only one will be discussed, that of U8-2 and U8-6.

2-38.24 So long as the current drawn by the +15 V supply is less than about 70 mA, the voltage across R39 will be too low to cause U8-6 to conduct. As a consequence, U8-2 will act as a beta multiplier, reducing the amplitude of any line-related modulation on the supply before its application to circuits on the PC board. However, if sufficient current flows through R39 to cause U8-6 to conduct, it will begin to divert the base bias for U8-2, thus limiting the current which may be applied to the PC board.

2-38.25 Regulator for A22. U11 is an adjustable regulator which produces an output of +8.0 V for use by amplifier A22A5 and A22A11 on the Output Module Section 2. The regulator creates a 1.25 V difference between its output (pin 2) and adjustment (pin 3) terminals; this voltage defines the current through R51, which in turn defines the voltage across R52, and thus the output voltage of the device.

CHAPTER 3

MAINTENANCE

3-1. INTRODUCTION

3-1.1 This chapter contains maintenance procedures for corrective maintenance, performance test, and calibration to maintain the operating characteristics and specifications of the 1500 Series Synthesized Signal Generator (instrument). Corrective maintenance is troubleshooting the instrument to isolate the defective circuit, assembly, etc. Performance test is used to ascertain the operational status of the instrument and calibration is to adjust the respective circuits so as to return them to required specifications. A list of test equipment is included which designates the equipment required for the testing and alignment procedures outlined in the corrective maintenance, performance test, and calibration procedures.

3-2. RECOMMENDED TEST EQUIPMENT

3-2.1 Table 3-1 lists the recommended tools and test equipment for the 1500 Series which are necessary to perform the inspection test and calibration procedures for the instrument. Substitute items, if used, must perform in accordance with the requirements specified in Table 3-1.

3-3. PERFORMANCE

3-3.1 The performance test procedures provide verification of specifications and proper operation of all circuits within the instrument. The procedure is intended to demonstrate general instrument function and compliance with critical specifications. The tests are grouped according to the performance requirement and not in a specific sequence.

3-3.2 Test Equipment as required in the performance test is named and referenced by index number as listed in Table 3-1.

3-3.3 The following definitions apply throughout this procedure.

a. INSTRUMENT: Refers to the Model 1500 Series under test.

b. PROGRAM: The act of providing new control data to the instrument. Programming may be done manually, or except for ac power switching, via the IEEE-488 bus.

Table 3-1. Recommended Test Equipment

	Type	Model	Use*
1.	GENERATOR, RF, Low Power. Capable of producing an RF output of +10 dBm at any frequency from 60- to 1950 MHz.	Wavetek 2002A	P T
2.	AMPLIFIER, Power. Capable of delivering 3 W at 500 MHz from an input of +10 dBm.	EIN 503L	P T
3.	POWER SUPPLY. Capable of providing 1A at 50 V.	Systron Donner HR60-A	P T
4.	POWER SUPPLY. Capable of providing 0 to 120 Vdc into a 50 ohm load.	Hewlett-Packard 6216A	PAT
5.	COUNTER, RF/Microwave. Capable of measuring frequencies from 100 kHz to 2500 MHz with 1-Hz resolution. The counter's internal timebase must have an accuracy of better than 1 part in 10^{-8}.	Systron Donner 6246A	PAT

Table 3-1. Recommended Test Equipment — Continued

Type		Model	Use*
6.	TRANSFORMER, Variable. Capable of providing an adjustable ac supply voltage from 90% to 110% of the local ac line (mains) voltage (103.5 to 126.5 Vac for 115 Vac), to loads of up to 200 watts.	Powerstat 3PN136B	P T
7.	ANALYZER, Spectrum. Capable of measuring frequencies from 20 Hz to 40 MHz with a frequency span/division capability of 100 Hz or less, and resolution bandwidths of 100 Hz or less. Must have ultimate noise floor no greater than −145 dBm in a 1-Hz beamwidth.	Hewlett-Packard 3585A	P T
8.	ANALYZER, Spectrum. Capable of measuring frequencies from 10 MHz to 18 GHz with a frequency span/division capability to 100 Hz, resolution bandwidth to 100 Hz, capable of being phase-locked to its input signal, and with zero-span mode operation.	Hewlett-Packard 8565A	PAT
9.	PHASE NOISE TEST FIXTURE	Systron Donner	P T
10.	SYNTHESIZED SIGNAL GENERATOR	Systron Donner 1502	P T
11.	OSCILLOSCOPE. Capable of measuring voltages from 0.005 V per division to 20 V per division, with timebase ranges from 100 ms per division to 10 ns per division, with 1 Megohm nominal dc input impedance, and with a rise time of less than 5 ns.	Tektronix 475A	PAT
12.	VARIABLE LENGTH LINE	Micro Lab/FXR ST-05N	P T
13.	RF POWER METER. Capable of measuring RF power levels from −30 dBm to +20 dBm with a resolution of 0.01 dB, when used with compatible RF POWER METER HEAD #14.	Hewlett-Packard 436A	PAT
14.	RF POWER METER HEAD. Capable of measuring the RF power level of signals from 0.450 to 2000 MHz, and from −30 dBm to +20 dBm, when used in conjunction with compatible RF POWER METER #13.	Hewlett-Packard 8482A	PAT
15.	SELECTIVE LEVEL METER, Measuring Receiver. Capable of measuring RF power levels from −127 dBm to +20 dBm; AM rates from 20 Hz to	Hewlett-Packard 8902A with HP 11722A	P T

Table 3-1. Recommended Test Equipment — Continued

	Type	Model	Use*
	100 kHz, depth to 99%, audio distortion; and FM rates from 20 Hz to 200 kHz, deviation to 400 kHz, audio distortion, at frequencies from 150 kHz to 1300 MHz.		
16.	GENERATOR, Audio Frequency. Capable of producing a sine wave output with less than 1% total harmonic distortion at frequencies from 10 Hz to 10 MHz, with an output amplitude adjustable from 0 to 3 V peak into loads of 50 ohm and 600 ohm.	Hewlett-Packard 651B	PAT
17.	MIXER, RF/Microwave. Capable of producing a 50 MHz IF output frequency for RF inputs of 10 to 2000 MHz at +5 dBm nominal, and LO inputs of 10 to 2000 MHz at +10 dBm, with a maximum conversion loss of 8.0 dB, and with BNC connectors on all ports.	Minicircuits ZFM-150 (BNC)	P T
18.	TERMINATION, 50 Ohm. Feedthrough termination type, with a VSWR less than 1.20 from dc to 2.0 GHz, capable of dissipating 2 W, and with BNC male and female connectors on opposing ends.	Engelmann Microwave T153BS Tektronix 011-0049-01	PAT
19.	VOLTMETER, Digital. Capable of measuring dc voltages from 1 V full scale to 1000 V full scale, and ac voltages from 1 V full scale to 500 V full scale, with a resolution of 1 part in 1000 (0.0001 V to 1 V, depending on range).	Systron Donner 7241A	AT
20.	DIRECTIONAL COUPLER. 10 MHz to 2000 MHz −20 dB coupling	Mini Circuits ZFDC-20-5	AT
21.	TOOL, Screwdriver. Blade length of 1/8 inch (3mm) nominal, width 1/8 inch (3mm) nominal, thickness 0.025 to 0.040 inch (0.6 to 1.0mm) nominal. Must be non-conductive and non-magnetic.	Various or locally fabricated	AT
22.	JUMPER. Zero ohm test lead.	Systron Donner A10W2	AT
23.	ANALYZER, Audio Distortion. Capable of measuring 0.1% harmonic distortion for audio frequencies from 10 Hz to 100 kHz.	Hewlett-Packard 334A	AT
24.	GENERATOR, Pulse. Capable of producing pulses with repetition rates from 10 Hz to 50 kHz, with widths adjustable from 6 μs to	Systron Donner 101D	P T

Table 3-1. Recommended Test Equipment — Continued

	Type	Model	Use*
	50 ms, with rise times adjustable from 3 μs to 20 ms, with an output amplitude adjustable from 0 to 110 V peak, and with an output impedance of 50 ohm.		
25.	Coax Cable, 50 Ohm. Locally fabricated, suitable for use to 2 GHz with a male BNC connector at each end. Cable length 3 feet (1 m) must not exceed 6 feet (2 m). Three required.	Any	PAT
26.	Adapter, Type UG201A/U; BNC female and Type N male connectors. Two required.	Americon 3082-2320	PAT
27.	Adapter, SMA female and BNC female.	Omni-Spectra 21190 Americon 2082-2320	PAT
28.	Adapter, SMB female and BNC female. Two required.	Omni-Spectra 81170 Americon 5182-2320	PAT
29.	Adapter, SMB male and BNC female.	Omni-Spectra 81190 Americon 5180-2320	PAT
30.	Tee Adapter. Two SMB male connectors, one SMB female.	Cablewave 700220 Cablewave 700224	PAT
31.	Capacitor, DC Blocking. Suitable for RF frequencies to 2000 MHz and dc voltages up to 50 V. Consists of an 0.001 μF capacitor between a BNC male and BNC female connector which have their outer conductors connected together. NOTE: The purpose of this device is to protect the input circuitry of Spectrum Analyzer #8.	Micro-Lab/FXR HR10B	PAT
32.	TIME MEASURING DEVICE. Capable of measuring elapsed time for periods of 30 seconds to 1 hour. This may be a wall clock or wristwatch of nearly any description.	Any	AT
33.	WRENCH, Torque. Preset to 8 inch-pounds torque, with removable head suitable for SMA connectors. Required for calibration procedure and field service to guarantee correct torque on SMA connectors.	Omni-Spectra 2098-5065-43	AT
34.	LOW LEVEL TEST FIXTURE.	Systron Donner	P
35.	EXTENDER TEST KIT. Contains Extender Cards (2) and Extender Cables (7).	Systron Donner 08313901	PAT

*P = Performance Test A = Calibration Adjustment T = Troubleshooting

c. FAILURE: The inability of the instrument to perform in accordance with specifications. This may indicate the need for instrument recalibration and/or repair.

3-3.4 Accept/Reject Criteria. The successful completion of all steps in this procedure, as indicated by the absence of any FAILURE, is sufficient to demonstrate correct instrument function and compliance with critical specifications.

3-4. INITIAL TURN-ON

1. Place the instrument POWER switch to STBY. Disconnect the instrument power cord from the AC line and from the AC power connector on the instrument's rear panel.

CAUTION

Incorrect fuse values may cause instrument damage.

2. Temporarily remove and physically verify that the instrument AC line voltage selector and AC line fuse are correct for the local AC line voltage. Reinstall the selector and fuse. Refer to Operating Manual Chapter 2 for proper fuse rating if necessary.

3. Reconnect the power cord, first to the instrument AC power connector, then to the AC line supply.

4. Place the instrument POWER switch in the ON position. Verify that the front panel LED annunciators and indicators all illuminate simultaneously for a few seconds. Lack of illumination indicates a FAILURE.

5. Verify that each segment of the front panel LCD data displays turn on for a short time. Failure of a segment to turn on indicates a FAILURE.

6. Verify that the instrument displays indicate the following conditions:

   Modulation:
   AM Depth 0.0%
   Frequency:
   CW 1000.000,000 MHz
   Level:
   LEVEL −140.0 dBm
   Internal and external AM, or FM, and PULSE Modulation:
   Off
   Sweep Start:
   Off ($\overline{\text{sweeping}}$)
   Sweep Freq.:
   On
   Sweep Level:
   Off
   Sweep Mode:
   Cont
   FM SENS:
   1 MHz/V
   RF Mute:
   Off (RF $\overline{\text{muted}}$)
   Edit/modify mode:
   Inactive (off)

7. Inability to meet the requirements of steps 4 through 6 constitutes a FAILURE.

NOTE

If a FAILURE is detected by the instrument CPU, an error code will appear in the modulation display. See Troubleshooting, paragraph 3-53.

3-5. INPUT OVERLOAD TEST

3-5.1 Successful completion of the entirety of the remainder of the Performance Test Procedure indicates that the Input Overload Test has been passed.

3-5.2 Reverse RF Power

1. Perform this test with the AC power ON.

2. Connect RF output of signal generator #1 to the input of power amplifier #2. Adjust the signal generator for RF output frequency 500 MHz with RF output level +10 dBm.

3. Program the instrument for any frequency from 0000.450 MHz to 2000.000 MHz. Program the instrument to RF on ($\overline{\text{muted}}$).

4. Apply the output of high power RF amplifier to the instrument's RF output connector. Verify that error message E23.1 appears in the modulation display. Remove high power RF amplifier. Verify that error message E23.1 disappears.

5. Apply +50 Vdc from power supply #3 to the RF output connector. Remove this voltage after 60 seconds have elapsed.

6. Apply −50 Vdc from power supply #3 to the RF output connector. Remove this voltage after 60 seconds have elapsed.

3-6. FREQUENCY ACCURACY TEST

1. Failure to allow a minimum 30-minute warm-up time for the instrument or counter may result in an erroneous FAILURE. Full accuracy requires that ac power be applied for 72 hours.

2. This is not a test of the instrument's performance over temperature, but an evaluation of the instrument's RF frequency accuracy at a known temperature.

3. Connect frequency counter #5 to the instrument's RF output connector. Set the counter to provide a resolution of 1 Hz. Connect the frequency counter timebase to a known standard.

4. Program the instrument for a CW RF level of −7.0 dBm.

5. For the frequencies in step 6 perform the following:

   a. Program the instrument to the selected frequency.

   b. Verify that the counter indicates the correct frequency within:
      2 parts in 10^{-6} (temperature 15 to 35°C); or
      10 parts in 10^{-6} (temperature 0 to 50°C).

6. List of Frequencies.

   0001.000 MHz
   0250.000 MHz
   0500.000 MHz
   1000.000 MHz
   1500.000 MHz
   0249.999 MHz
   0499.999 MHz
   0999.999 MHz
   1499.999 MHz
   2500.000 MHz

7. Inability to meet the requirements of step 5 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-7. SPECTRAL PURITY HARMONICS TEST

1. Definition: A harmonic is any signal whose frequency is an exact integer multiple of the programmed output frequency.

2. The accuracy of these measurements depend in part on the characteristics of the spectrum analyzer. Large signal amplitudes can cause the analyzer to display harmonics which are not present on the input signal.

3. Connect the instrument's RF output to the input connector of spectrum analyzer #7 (frequencies and harmonics below 30 MHz) or spectrum analyzer #8 (frequencies and harmonics above 30 MHz). Set the spectrum analyzer for 30 dB of RF attenuation and for a reference level of +20 dBm.

4. Program the instrument for a CW RF level of +13 dBm.

5. For the frequencies in step 6 perform the following:

   a. Program the instrument to the selected frequency. Tune the spectrum analyzer to the same frequency and note the amplitude of the RF signal.

   b. Tune spectrum analyzer to the frequencies of all the harmonics of the selected signal that are within the frequency band of the 1501/1502 instrument. Verify that the amplitude of any harmonic is at least 25 dB below the amplitude of the selected signal.

6. List of Frequencies.

(Model 1501)	(Model 1502)
10 MHz	10 MHz
250 MHz	250 MHz
400 MHz	400 MHz
650 MHz	650 MHz
750 MHz	750 MHz
	1000 MHz
	1250 MHz

7. Inability to meet the requirements of step 5 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-8. SPECTRAL PURITY SUB-HARMONICS TEST (MODEL 1502 ONLY)

1. Definition. A sub-harmonic is any signal whose frequency is exactly equal to the frequency of the programmed signal divided by an integer.

2. Connect the instrument's RF output to the input connector of spectrum analyzer #8. Set the spectrum analyzer for 30 dB of RF attenuation and for a reference level of +10 dBm.

3. Program the instrument for a CW RF level of +7.0 dBm.

4. For the frequencies in step 5, perform the following:

   a. Program the instrument to the selected frequency. Tune the spectrum analyzer to the same frequency and note the amplitude of the RF signal.

   b. Tune the spectrum analyzer to 1/2 of the selected frequency. (The design of this instrument precludes generation of sub-harmonics for RF output frequencies below 1500 MHz.)

   c. Verify that the measured amplitude of any sub-harmonic is at least 20 dB below the measured amplitude of the programmed signal.

5. List of Frequencies.

   1500.000 MHz
   2000.000 MHz
   2500.000 MHz

6. Inability to meet the requirements of step 4 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-9. SPECTRAL PURITY SPURIOUS SIGNALS TEST

1. Definition. A spurious signal is any signal not a harmonic or sub-harmonic of the output signal. This includes any sidebands (other than desired modulation sidebands) on the instrument's RF output, and any signals caused by circuitry within the instrument, but not signals generated by external sources which influence the instrument's output.

2. Connect the instrument's RF output to the input connector of spectrum analyzer #7 (frequencies below 30 MHz) or spectrum analyzer #8 (frequencies above 30 MHz). Set the spectrum analyzer for 30 dB of RF attenuation and a reference level of +10 dBm.

3. Program the instrument for a CW RF level of +7.0 dBm.

4. For the frequencies in step 5, perform the following:

   NOTE

   In most cases, the automatic settings of the spectrum analyzer should prove suitable.

   a. Program the instrument to the selected frequency. Tune the spectrum analyzer to the same frequency and adjust its span and resolution bandwidth to clearly display any spurious signals.

   b. For spurious signals within 20 kHz of the programmed frequency, if the spurious signal is related to the frequency of the AC power line, to the rotation of the cooling fan, or to data transfer to the instrument displays and/or annunciators, verify that the measured amplitude of the spurious signal, in a 1 Hz bandwidth, is at least 45 dB lower than the amplitude of the programmed signal.

   c. For spurious signals not described in step 4b, and for all spurious signals greater than 20 kHz from the programmed frequency, verify that the measured amplitude of the spurious signals, in a 1 Hz bandwidth, is below the amplitude of the programmed signal by at least:

      60 dB (frequencies 1500 MHz and below), or
      54 dB (frequencies above 1500 MHz).

5. List of Frequencies.

   Model 1501/1502
   12.500 000 MHz   49.999 999 MHz
   200.000 000 MHz   250.000 000 MHz
   399.999 999 MHz   400.000 000 MHz
   649.999 999 MHz   650.000 000 MHz
   999.999 999 MHz   1000.000 000 MHz

Model 1502 Only	
1500.000 000 MHz	2000.000 000 MHz
2500.000 000 MHz	

6. Inability to meet the requirements of step 4 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-10. SPECTRAL PURITY RESIDUAL MODULATION TEST

1. Test Equipment Setup.

    a. Frequencies below 1300 MHz. Connect the instrument's RF output to the RF input of modulation analyzer #9.

    b. Frequencies 1300 MHz and above. Connect the instrument's RF output to the RF input connector of spectrum analyzer #8. Connect the spectrum analyzer's rear panel 21.4 MHz IF output connector to the RF input connector of modulation analyzer #9.

2. Program the instrument for a CW RF level of +13 dBm.

3. Residual AM.

    a. Adjust the modulation analyzer as follows:

HP Filter:	300 Hz
LP Filter:	3 kHz
Measurement:	AM
Detector:	Peak ±/2

    b. For the frequencies in step 5, verify the AM depth is not greater than 0.02% (−80 dBc).

4. Residual FM.

    a. Adjust the Modulation Analyzer as follows:

HP Filter:	300 Hz
LP Filter:	3 kHz
Measurement:	FM
Detector:	Peak ±/2

    b. For the frequencies in step 5, verify the FM deviation is not greater than:

<10 Hz rms to 1500 MHz
<20 Hz rms to 2500 MHz

5. List of Frequencies.

Model 1501/1502	
10.000 MHz	249.999 MHz
250.000 MHz	499.999 MHz
500.000 MHz	999.999 MHz
1000.000 MHz	1499.999 MHz

Model 1502 Only	
1500.000 MHz	2500.000 MHz

6. Inability to meet the requirements of step 3 or step 4 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-11. SPECTRAL PURITY PHASE NOISE AND NOISE FLOOR TEST

1. Test Equipment Setup.

    a. Connect the instrument's RF output to the input port of the directional coupler #20. Connect the coupled port of the directional coupler to the input connector of spectrum analyzer #8 and the output port to the RF input of phase noise test fixture #9.

    b. Connect the RF output of signal generator #10 to the LO input of phase noise test fixture. Connect the IF output of phase noise test fixture to the input connector of spectrum analyzer #7.

    c. Connect the scope output of phase noise test fixture to the vertical input of oscilloscope #11.

    d. Connect the instrument's EXT 10 MHz output connector to one connector of variable length line #12 and the EXT 10 MHz input of signal generator #10 to the other.

2. Adjust the test setup as follows:

Instrument	
RF O/P Level:	+7 dBm
FM Rate:	19.65 kHz

Signal Generator #10	
RF O/P Level:	+7 dBm

Spectrum Analyzer #7
RF Attenuator: 20 dB
Ref Level: −50 dBm

Spectrum Analyzer #8
RF Attentuator: 20 dB
Ref Level: +10 dBm

Oscilloscope #11
Signal: DC coupled 5V/div, 0 V at center line

3. Narrow Band SSB Phase Noise.

   a. Set switch on phase noise test set to narrow band. For frequencies in step 5 adjust the instrument and signal generator to the selected frequency.

   b. Set the instrument to INT FM on. Adjust spectrum analyzer #8 to display the selected frequency with FM sidebands.

   c. Adjust the FM deviation around a nominal 180 Hz for −50 dBc sidebands displayed on spectrum analyzer #8.

   d. Adjust the variable length line for 0 V displayed on oscilloscope. (This indicates the two generators are in quadrature.)

   e. Adjust spectrum analyzer #7 to display the baseband FM signal level as the reference level. Adjust the instrument to INT FM off.

   f. Adjust the spectrum analyzer for noise level measurement. Verify that the SSB phase noise in a 1 Hz bandwidth is not greater than,

      −127 (measurement −50 dB)
      −121
      −115

4. Wideband Noise Floor.

   a. Set switch on phase noise test set to wideband. Follow the procedure in step 3a.

   b. Adjust spectrum analyzer #7 to display signals at 3 MHz in the center of the screen. Set the marker at 3 MHz.

   c. Adjust the spectrum analyzer for noise level measurement. Verify that the broadband noise floor in a 1 Hz bandwidth is not greater than −135 dBc.

5. List of Frequencies.

150.000 MHz	249.999 MHz
250.000 MHz	499.999 MHz
500.000 MHz	999.999 MHz
1000.000 MHz	2000.000 MHz

6. Inability to meet the requirements of step 3 or step 4 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-12. RF OUTPUT LEVEL FLATNESS TEST

1. Connect measuring receiver #15 directly to the instrument's RF output connector. Do not use an interconnecting cable of any kind.

2. Program the instrument for a CW RF level of +7.0 dBm.

3. Stepping the instrument from 0.450 to 1499 MHz (Model 1501), or 0.450 to 2500 MHz (Model 1502), in 10-MHz steps, adjust the measuring receiver to indicate the RF power at each frequency step. Verify that the RF power level stays within ±1.0 dB.

4. Inability to meet the requirement of step 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-13. RF OUTPUT LEVEL ACCURACY TEST

1. Connect measuring receiver #15 to the instrument's RF output connector.

2. For the frequencies in step 4 perform the following:

   a. Program the instrument for an RF level of +13 dBm. Adjust the measuring receiver to indicate the RF power at each frequency.

   b. Note the measured RF power level to the nearest 0.01 dB.

c. Decrement the RF level to 0.0 dBm in 1 dB steps. For each step verify that the RF power display indicates the programmed RF power level, and that the measured RF output level is within ±1.0 dB.

3. For the frequencies in step 4, perform the following:

   a. Program the instrument to the selected frequency with a CW RF level of +3.0 dBm.

   b. For RF frequencies 1300 MHz and below, decrement the RF level to −120 dBm in 10-dB steps. For each step verify that the measured RF output level is within ±1.0 dB of the programmed RF level.

   c. For frequencies 1300 MHz and above, decrement the RF level to −17 dBm in 10-dB steps. Verify that the measured RF output level is within ±1.0 dB of the programmed level.

   d. Take note of the level at −17 dBm to the nearest 0.01 dB. Remove the measuring receiver from the instrument.

   e. Connect the instrument's RF output connector to the RF input of low level test fixture #34. Connect the RF output of signal generator #10 to the LO input of the test fixture. Connect the input of measuring receiver #15 to the IF output of the test fixture. Connect the 10-MHz reference output of the signal generator to the 10-MHz reference input of the measuring receiver and the instrument. Adjust the measuring receiver for a tuned RF frequency of 20.270 MHz.

   f. Program the signal generator to the selected frequency plus 20.270 MHz, RF level to +7.0 dBm.

   g. Program the instrument to CW RF level of −17 dBm. Note the difference between the measured RF level and the RF level measured in step d.

NOTE

Test equipment to measure power levels below −127 dBm is not available.

   h. Decrement the RF level to −120 dBm in 10-dB steps. For each step, verify that the measured RF output level, adjusted by the difference noted in step g, is within ±1.0 dB of the programmed level.

4. List of Frequencies.

0010.000 MHz	1000.000 MHz
0100.000 MHz	1499.000 MHz
0250.000 MHz	1500.000 MHz
0400.000 MHz	2500.000 MHz
0650.000 MHz	

5. Inability to meet the requirements of steps 2 or 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-14. AMPLITUDE MODULATION INTERNAL RATES TEST

1. Connect the instrument's RF output to the RF input connector of measuring receiver #15. Adjust the measuring receiver to indicate AM audio frequency.

2. Program the instrument to an RF frequency of 1000.000 MHz with an RF level of +7.0 dBm. Program the instrument for sweep off, internal and external FM off, external AM off, and internal AM on with an AM depth of 70%.

3. Modulation Rate Tests.

   a. Program the instrument for an AM rate of 20.0 Hz. Verify an AM rate of 20.0 Hz.

   b. Program the instrument for an AM rate of 99.99 kHz. Verify an AM rate of 99.99 kHz.

4. Inability to meet the requirements of step 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-15. INTERNAL AMPLITUDE MODULATION DEPTH AND DISTORTION TEST

1. Connect the instrument's RF output to the RF input of measuring receiver #15. Adjust the measuring receiver to indicate AM ± peak/2 or AM Audio distortion as appropriate.

2. Program the instrument for a CW RF level of +7.0 dBm. Program the instrument for sweep off, internal and external FM off, external AM off, and internal AM on with an AM rate of 1000 Hz.

3. For the frequencies in step 4, perform the following:

    a. Program the instrument to the selected frequency.

    b. Program the instrument for an AM depth of 30.0%. Verify that the measured AM depth is between 28.2% and 31.8% (±6%). Verify that the AM distortion does not exceed 2%.

    c. Program the instrument for an AM depth of 70.0%. Verify that the measured AM depth is between 65.8% and 74.2% (±6%). Verify that the AM distortion does not exceed 4%.

    d. Program the instrument for an AM depth of 90.0%. Verify that the measured AM depth is between 84.6% and 95.4% (±6%). Verify that the AM distortion does not exceed 6%.

4. List of Frequencies.

    20 MHz
    500 MHz
    1200 MHz
    250 MHz
    1000 MHz
    1300 MHz

5. Inability to meet the requirements of step 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-16. EXTERNAL AMPLITUDE MODULATION TEST

1. Test Equipment Setup.

    a. Connect the output of audio generator #16 to the instrument's external AM input connector.

    b. Connect the instrument's RF output to the RF input connector of measuring receiver #15. Adjust the measuring receiver to indicate AM depth.

2. Program the instrument for an RF level of +7.0 dBm. Program the instrument for sweep off, internal and external FM off, internal AM off, and external AM on.

3. For the frequencies in step 4, perform the following:

    a. Program the instrument to the selected frequency.

    b. Set the frequency of the audio generator to 20 Hz, and adjust its output amplitude for a level of 0.90 V peak (1.80 V peak-to-peak) into the 600 ohm load provided by the instrument. Verify that the measuring receiver indicates a depth of 90.0% AM, ±6%, and ±0.1% for each mV error in the audio signal amplitude.

    c. Set the frequency of the audio generator to 100 kHz and adjust its output amplitude for a level of 0.70 V peak (1.40 V peak-to-peak) into the 600 ohm load provided by the instrument. Verify that the measuring receiver indicates a depth of no less than 49.5% AM.

4. List of Frequencies.

    20 MHz
    500 MHz
    1200 MHz
    250 MHz
    1000 MHz
    1300 MHz

5. Inability to meet the requirements of paragraph 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-17. AMPLITUDE MODULATION INCIDENTAL PHASE MODULATION TEST

1. Test Equipment Setup.

    a. Connect the instrument's RF output to the RF input connector of measuring receiver #15. Adjust the measuring receiver to the following:

    HP Filter: 300 Hz
    LO Filter: 3 kHz
    Measurement: ϕ M
    Detection: Peak ±/2

2. Program the instrument for sweep off, internal and external FM off, external AM off, and internal AM on with an AM rate of 1000 Hz and an AM depth of 30.0%.

3. For the frequencies in step 4, perform the following steps.

    a. Program the instrument to the selected frequency.

    b. Verify that any incidental FM deviation indicated by the modulation analyzer is not greater than 0.3 radians.

4. List of Frequencies.

    20 MHz
    500 MHz
    1200 MHz
    250 MHz
    1000 MHz
    1300 MHz

5. Inability to meet the requirements of step 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-18. FREQUENCY MODULATION INTERNAL RATES TEST

1. Connect the instrument's RF output to the RF input connector of measuring receiver #15. Adjust the measuring receiver to indicate FM audio frequency.

2. Program the instrument to an RF frequency of 1000.000 MHz and an RF level of +7.0 dBm. Program the instrument for sweep off, internal and external AM off, external FM off, and internal FM on with an FM deviation of 100 kHz.

3. Modulation Rate Tests.

    a. Program the instrument for an FM rate of 20.0 Hz. Verify an FM rate of 20.0 Hz.

    b. Program the instrument for an FM rate of 99.99 kHz. Verify an FM rate of 99.99 kHz.

4. Inability to meet the requirements of step 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-19. FREQUENCY MODULATION DEVIATION AND DISTORTION TEST

1. Test Equipment Setup.

    a. Frequencies 1300 MHz and below. Connect the instrument's RF output to the RF input connector of measuring receiver #15.

    b. Frequencies above 1300 MHz (Model 1502). Connect the instrument's RF output to the RF input connector of spectrum analyzer #8. Connect the spectrum analyzer's rear panel 21.4-MHz IF output connector to the RF input connector to the RF input connector of measuring receiver #15.

    c. Adjust the measuring receiver to indicate FM distortion, 1-kHz rate or FM deviation as appropriate. Select the 300-Hz high-pass filter and the 15-kHz low-pass filter to remove system noise.

2. Program the instrument for an RF level of +7.0 dBm, with sweep off, internal and external AM off, external FM off, and internal FM on with an FM rate of 1000 Hz.

3. For the frequencies in step 4, perform the following:

    a. Program the instrument to the selected frequency. If appropriate, tune the spectrum analyzer to the same frequency, then place the spectrum analyzer in the zero-span with a resolution bandwidth of 3 MHz.

    b. Program the instrument for an FM deviation of 25 kHz. Verify that the measured deviation is between 23.3 and 26.7 kHz (±7%). Verify that the FM distortion does not exceed 2%.

c. Program the instrument for an FM deviation of 50 kHz. Verify that the measured deviation is between 46.5 and 53.5 kHz (±7%). Verify that the FM distortion does not exceed 1%.

4. List of Frequencies.

Model 1501/1502
20 MHz
250 MHz
500 MHz
1000 MHz
1200 MHz
1300 MHz

Model 1502 Only
1500 MHz
2500 MHz

5. Inability to meet the requirements of step 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-20. EXTERNAL FREQUENCY MODULATION TEST

1. Test Equipment Setup.

   a. Frequencies 1300 MHz and Below. Connect the instrument's RF output to the RF input connector of measuring receiver #15.

   b. Frequencies Above 1300 MHz (Model 1502). Connect the instrument's RF output to the RF input connector of spectrum analyzer #7. Connect the spectrum analyzers rear panel 21.4-MHz IF output connector to the RF input of measuring receiver #15.

   c. Adjust the measuring receiver to indicate RF deviation.

2. Program the instrument for an RF level of +7.0 dBm. Program the instrument for sweep off, internal and external AM off, internal FM off and external FM on, with an external FM sensitivity of 10 kHz/volt.

3. Connect the output of audio generator #16 to the instrument's external FM input connector.

4. For the frequencies in step 5, perform the following:

   a. Program the instrument to the selected frequency. If appropriate, tune the spectrum analyzer to the same frequency, then place the spectrum analyzer in the zero-span mode with a resolution bandwidth of 3 MHz.

   b. Program the instrument for DC FM on. Set the frequency of the audio generator to 1.0 kHz, and adjust its output amplitude to 0.707 V rms. Verify that the measured deviation is between 93 to 107 kHz (±7%).

   c. Repeat step b with 100 kHz/volt FM sensitivity.

5. List of Frequencies.

Model 1501/1502
20 MHz
250 MHz
500 MHz
1000 MHz
1200 MHz
1300 MHz

Model 1502 Only
1500 MHz
2500 MHz

6. Inability to meet the requirements of step 4 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-21. FREQUENCY MODULATION INCIDENTAL AM TEST

1. Test Equipment Setup:

   a. Frequencies 1300 MHz and Below. Connect the instrument's RF output to the RF input connector of measuring receiver #15. Adjust the measuring receiver to indicate AM depth.

   b. Frequency Above 1300 MHz. Connect the instrument's RF output to the RF input connector of spectrum analyzer #8. Connect the spectrum analyzers rear panel 21.4 MHz IF output connector to the RF input connector of measuring receiver #15. Adjust the measuring receiver to indicate AM depth.

2. Program the instrument for an RF level of +7.0 dBm. Program the instrument for sweep off, internal and external AM off, external FM off, and internal FM on with an FM rate of 1000 Hz and an FM deviation of 20 kHz.

3. For the frequencies in step 4, perform the following:

   a. Program the instrument to the selected frequency. If appropriate, tune the spectrum analyzer to the same frequency, then place the spectrum analyzer in the zero-span mode with a resolution bandwidth of not less than 1 MHz.

   b. Verify that any incidental AM indicated by the modulation analyzer is not greater than 0.3% peak.

4. List of Frequencies:

   Model 1501/1502
   20 MHz
   500 MHz
   1200 MHz
   250 MHz
   1000 MHz
   1300 MHz

   Model 1502 Only
   1500 MHz
   2500 MHz

5. Inability to meet the requirements of step 3 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-22. PULSE MODULATION SWITCH POINT AND ON/OFF RATIO TEST

1. Connect the instrument's RF output to the input connector of spectrum analyzer #8. Set the spectrum analyzer's step attenuator to the 20-dB step and its reference level to +7 dBm, frequency span to 100 MHz.

2. Connect pulse generator #24 to the external pulse input of the instrument. Adjust the pulse generator for a 100-kHz square wave TTL signal.

3. Program the instrument for an RF level of +7.0 dBm. Program the instrument for sweep off, internal and external AM off, internal and external FM off, and external PULSE modulation on.

4. For the frequencies in step 5, perform the following:

   a. Program the instrument to the selected frequency. Tune the spectrum analyzer to the same frequency and adjust the spectrum analyzer to view the signal in the zero-span mode, VIDEO FILTER to OFF, SWP TIME/DIV to 5 usec.

   b. Verify that the pulse on/off ratio is at least 60 dB.

5. List of Frequencies.

   Model 1501/1502
   20 MHz
   500 MHz
   1000 MHz
   250 MHz
   999 MHz
   1499 MHz

   Model 1502 Only
   1500 MHz
   2500 MHz

6. Inability to meet the requirements of step 3 constitutes a FAILURE.

3-23. PULSE MODULATION PULSE SHAPE AND TIMING TEST

3-23.1 The test method described below avoids superimposition on the oscilloscope display of the switching edge which drives the pulse modulator. As the amplitude of the switching edge can exceed the amplitude of the RF pulse by an order of magnitude or more, a major measurement error can occur if a detector diode is used to measure pulse parameters.

1. Test Setup.

   a. Connect the instrument's RF output to the LO input connector of mixer #17. Program the instrument for an RF output level of +5.0 dBm. Program the instrument to sweep off, internal and external AM off, internal and external FM off, and external PULSE modulation on.

   b. Connect the output of RF generator #1 to the RF input connector of the mixer. Set the generator's RF output level to +10 dBm.

   c. Connect the IF output of the mixer to the vertical input connector of oscilloscope #11 using 50-ohm termination #18 at the oscilloscope input.

   d. Connect the output of pulse generator #24 to the instrument's PULSE input connector. Adjust the pulse generator for a pulse repetition rate of 20 kHz and a pulse width of 20 s, with an output level of +5 volts into the 50-ohm load presented by the instrument.

2. For the frequencies in step 3, perform the following:

   a. Program the instrument for the selected frequency. Set the RF generator for a frequency 50 MHz higher or lower than the selected frequency.

   b. Verify that the RF pulse rise (RF on) time is less than 100 ns as measured from 10% to 90% of final RF on pulse amplitude.

   c. Verify that the RF pulse fall (RF off) time is less than 100 ns, as measured from 90% to 10% of final RF on pulse amplitude.

   d. Verify that any overshoot or ringing on the RF pulse is not more than 20% greater in amplitude than the final RF on pulse amplitude.

3. List of Frequencies:

   Model 1501/1502
   20 MHz 250 MHz
   500 MHz 999 MHz
   1000 MHz 1499 MHz

   Model 1502 Only
   1500 MHz 2500 MHz

4. Inability to meet the requirements of step 2 constitutes a FAILURE. Display of an error code during the performance of this test indicates a FAILURE.

3-24. IEEE-488 INTERFACE TEST

3-24.1 The purpose of this test is to demonstrate the ability of the instrument's IEEE interface to control instrument operation.

3-24.2 All instrument functions except for AC power switching are programmable using either CIIL or an alternate language. Refer to 1500 Series Operator's Manual for programming details.

3-24.3 The instrument's IEEE address can be determined by pressing RECALL – (minus) on the keyboard. The IEEE address can be changed by entering the new address with the keyboard and pressing STORE – (minus). Refer to 1500 Series Operator's Manual for permissible addresses.

1. RF Output Frequency. Connect the instrument's RF output to the input connector of frequency counter #5. Program various frequencies within the instrument's range and verify that each frequency is correct.

2. RF Output Level. Connect the instrument's RF output directly to power head #14 of RF power meter #13. Program various RF levels within the range of the instrument and the power meter, including at least one level for each attenuator step, and verify that each RF power level is within specification.

3. RF Step Attenuator. Connect the instrument's RF output to the input connector of measuring receiver #15. Program various RF levels within the range of the measuring receiver, including at least one level for each attenuator step, and verify that each RF power level is within specification.

4. Internal AM and FM Modulation.

   a. Program the instrument for 50% internal AM modulation at rates of 400 and 1000 Hz. Verify correct AM rates and depth.

   b. Program the instrument for 250 kHz FM deviation at rates of 400 and 1000 Hz. Verify correct FM rates and deviation.

5. External AM and FM Modulation.

   a. Connect the output of audio generator #16 to the instrument's external AM input connector. Adjust the audio generator to provide an output of 0.5 V peak. Program external AM modulation and verify correct instrument operation.

b. Connect the output of audio generator #16 to the instrument's external FM input connector. Adjust the audio generator to provide an output of 0.5 V peak. Program external FM modulation and verify correct instrument operation.

6. External PULSE Modulation. Connect the output of pulse generator #24 to the instrument's PULSE input connector. Program PULSE modulation on and verify correct instrument operation.

3-25. CALIBRATION/ALIGNMENT PROCEDURES

3-25.1 The following test and alignment procedures provide instructions for adjusting the instrument. These procedures describe the test necessary to verify proper calibration, and those steps required to calibrate a fully assembled, properly functioning instrument.

3-25.2 AC Line Voltage. It is assumed through this procedure that the proper AC line voltage is selected. Refer to 1500 Series Operator's Manual for details on line voltage selection, if necessary.

1. Temporary removal of the instrument's top cover is required.
2. Unless specified otherwise, it is assumed throughout this procedure that the instrument is operating normally after the required warmup period. Inadequate warmup time may result in incorrect calibration.
3. It is highly desirable that all performance checks and calibrations be followed in the order given below. In many cases, one or more circuits on other PC boards influence the operation of the circuit under test, and may cause incorrect operation of that circuit.

3-25.3 Precautions. The list below describes the precautions which the calibration technician should take to avoid risk of personal injury and/or damage to the instrument. This list is not intended to be all-inclusive.

1. COMMON SENSE is a necessary safety precaution.
2. AC LINE VOLTAGE is present in the instrument even when the INSTRUMENT POWER switch is in the STBY position. Contact with this voltage or other voltages within the instrument, either directly or through conductive objects, can cause burns, injury, or even death.
3. HIGH TEMPERATURES can exist as a result of normal or abnormal instrument operation. This is particularly likely when the instrument top cover is removed. Contact with hot areas can cause severe burns. Do not touch any instrument component until you are certain it is safe to do so.
4. DO NOT INSERT any object into the fan. Contact with the blades can cause damage or personal injury.
5. MICROWAVE CABLE CONNECTORS require delicate handling. A torque of 8 inch-pounds is required for proper connection (for the average individual, this is slightly more than finger tight). Excess torque will destroy these connectors.
6. DO NOT REMOVE or install any of the instrument's PC boards or assemblies with the POWER switch in the ON position. Wait at least 30 seconds after placing the POWER switch in the STBY position before removing or installing any PC board or assembly. In the event that a power supply component is being serviced, disconnect the instrument's AC power cord as well.
7. DO NOT SHORT the control, power, or RF connections of any microwave component to ground or to any power supply. Doing so may damage the component or assembly.
8. DO NOT SHORT any power supply to ground or to any other supply. Doing so can cause extremely large currents to flow, and will damage the instrument and/or power supplies.
9. DO NOT wear loose or dangling objects when working on or near the instrument. These can get caught in rotating parts or touch dangerous voltages.

3-26. UNREGULATED POWER SUPPLIES CHECK

3-26.1 Apply ac power to the instrument via the power cord, and place the POWER switch to the STBY position.

3-26.2 Performance Check. Use voltmeter #19 and oscilloscope #11 for the following tests.

1. Bridge Rectifier U11. Measure the voltage at K1 pin 12 (A24C1+) and verify that the output is +11.0 to +12.5 Vdc, with a line frequency ripple component less than 0.5 V peak-to-peak.

2. Bridge Rectifier U12. Measure the voltage at K1 pin 19 (A16C7+) and verify that the positive output is +12.2 to +14.2 Vdc, with a line frequency ripple component less than 0.75 V peak-to-peak. Measure the voltage at K1 pin 22 (A24C11−) and verify that the negative output is −12.2 to −14.2 Vdc, with a line frequency ripple component less than 0.5 V peak-to-peak.

3. Bridge Rectifier U13. Measure the voltage at K1 pin 10 (A16C15+) and verify that the positive output is +25.0 to +29.5 Vdc, with a line frequency ripple component less than 0.5 V peak-to-peak. Measure the voltage at K1 pin 15 (A16C22−) and verify that the negative output is −25.0 to −29.5 Vdc, with a line frequency ripple component less than 0.5 V peak-to-peak.

4. Bridge Rectifier U14. Measure the voltage at K1 pin 7 (A16C29+) and verify that the output is +33.0 to +39.0 Vdc, with a line frequency ripple component less than 0.5 V peak-to-peak.

3-26.3 Calibration. There are no calibration adjustments.

3-27. A16 POWER SUPPLY CHECK

3-27.1 Apply ac power to the instrument via the power cord, and place the instrument power switch to the ON position.

3-27.2 Performance Check. Use voltmeter #19 and oscilloscope #11 for the following tests.

1. Rear panel U1, +5.0 V regulator. Measure the voltage at J1 pin 10 and verify that the output is +4.75 to +5.5 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

2. A16U3, +6.5 V regulator. Measure the voltage at J1 pin 4 and verify that the output is +6.30 to +6.70 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

3. Rear panel U4, −6.5 V regulator. Measure the voltage at J1 pin 11 and verify that the output is −6.30 to −6.70 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

4. A16U5, +17 V regulator #1. Measure the voltage at J1 pin 5 and verify that the output is +16.75 to +17.75 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

5. A16U6, +17 V regulator #2. Measure the voltage at J2 pin 1 and verify that the output is +16.75 to +17.75 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

6. A16U7, −17 V regulator #1. Measure the voltage at J1 pin 3 and verify that the output is −16.75 to −17.75 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

7. A16U8, −17 V regulator #2. Measure the voltage at J2 pin 4 and verify that the output is −16.75 to −17.75 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

8. A16U9, +26 V regulator. Measure the voltage at J1 pin 1 and verify that the output is +25.0 to +28.0 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

9. A16U10, +15 V regulator. Measure the voltage at J4 pin 1 and verify that the output is +14.25 to +15.75 Vdc, with a line frequency ripple component less than 50 mV peak-to-peak.

10. A16U2, cooling fan control. Verify that the voltage at J3 pin 2 is 20 to 22 V greater than the voltage at J3 pin 1 when the heatsink plate is at room temperature.

3-27.3 Calibration. There are no calibration adjustments.

3-28. INITIAL SELF-TEST ROUTINE

3-28.1 This procedure checks that the instrument performs its power-on self-test routine.

3-28.2 Performance Check.

1. Place the instrument POWER switch in the STBY position. After a period of 30 seconds place the POWER switch in the ON position.

2. Verify that the front panel LED annunciators and indicators simultaneously illuminate for a short time.

3. Verify that each segment of the front panel LCD data displays turn on for a short time.

4. Verify that the instrument displays indicate the following conditions:

   Modulation:
     AM DEPTH 0.0%
   Frequency:
     CW 1000.000,000 MHz
   Level:
     LEVEL −140.0 dBm
   Internal and external AM, FM, and
   PULSE Modulation:
     Off
   Sweep Start:
     Off ($\overline{\text{sweeping}}$)
   Sweep Freq:
     On
   Sweep Level:
     Off
   Sweep Mode:
     Cont.
   FM SENS:
     1 MHz/V
   RF Mute:
     Off (RF $\overline{\text{mute}}$)
   Edit/modify mode:
     Inactive (off)

5. If a FAILURE is detected during the self-test routine, an error code will be displayed. Refer to troubleshooting, paragraph 3-53 for a listing of such error codes, their meanings, and probable causes.

3-28.3 Calibration. There are no calibration adjustments.

3-29. REFERENCE OSCILLATOR A18 AND EXT 10 MHz OUT

3-29.1 Set frequency counter #5 as follows:

1. Switch counter timebase to EXT.

2. Connect 1 MHz or 10 MHz standard reference to the external 1-MHz/10-MHz input.

3-29.2 Performance Check.

1. Connect the instrument's 10-MHz output to oscilloscope #11 using 50 ohm termination #18.

2. Verify a 10-MHz 2 V peak-to-peak signal.

3. Remove oscilloscope. Connect the instrument's 10 MHz output to frequency counter #5 using 50 ohm termination #18.

4. Verify that the counter reads 10.000,000 MHz to within:

   2 Hz (temperature between 15 and 35°C)
   10 Hz (temperature between 0 and 50°C).

5. Remove the frequency counter.

3-29.3 Calibration.

1. If the requirements of paragraph 3-29.2 are met, adjustments are not required.

2. Connect the instrument's 10-MHz output to frequency counter #5 using the 50-ohm termination #18.

NOTE

This adjustment is sensitive and requires a delicate touch. Due to the resolution required, the counter gate period will typically be 10 seconds.

3. Using tool #21, adjust the frequency setting control of A18 until the counter reads exactly 10.000,000 MHz.

4. Observe the oscillator frequency for a period of 10 minues thereafter, to verify stability and accuracy of the adjustment.

5. Remove the frequency counter.

3-30. 100-MHz OSCILLATOR A14J5

3-30.1 Performance Check.

1. Remove the A14 PC board from the instrument and reinstall using extenders. Connect EXT

10-MHz output on rear panel to external 1 MHz/10-MHz input on the counter. Connect voltmeter #19 to A14TP1, and frequency counter #5 to A14J5.

2. Verify that the counter reads 100.000,000 MHz ±1 Hz. Verify a voltage of +5.0 V ±0.5 V.
3. Remove the counter #5. Connect spectrum analyzer #8 to A14J5. Tune the analyzer to 100 MHz. Verify that the analyzer displays a stable 100-MHz signal with an amplitude of −8 dBm ±2 dB.
4. Remove the spectrum analyzer. Reconnect the cable from A14J5 to A6J1.

3-30.2 Calibration.

1. If the requirements of paragraph 3-30.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove A14 PC board from the instrument and reinstall using extenders.
3. Connect frequency counter #5 to A14J5. Connect voltmeter #19 to A14TP1.
4. Using tool #21, adjust A14L10 for +4.90 to +5.10 Vdc. Verify that the counter reads 100.000,000 MHz ±1 Hz.
5. Remove the counter and voltmeter. Connect spectrum analyzer #8 to A14J5. Tune the analyzer to 100 MHz. Verify that the analyzer displays a stable 100—MHz signal with an amplitude of −8 dBm ±2 dB.
6. Remove the analyzer. Reinstall the A14 PC board in the instrument. Repeat paragraphs 3-30.1 and 3-30.2 if necessary. Reconnect the cable from A14J5 to A6J1.

3-31. SWITCHED 100-MHz REFERENCE A14J4

3-31.1 Performance Check.

1. Remove the cable connected to A14J4. Connect frequency counter #5 to A14J4. Verify that the counter indicates 100.0 MHz.
2. Remove the counter. Connect spectrum analyzer #8 to A14J4. Tune the analyzer to 100 MHz.
3. Program instrument to internal and/or external FM off. Verify that the analyzer displays a stable 100-MHz signal with an amplitude of −8 dBm ±2 dB.
4. Program instrument to internal and external FM on. Verify that the analyzer displays a stable 100 MHz signal with an amplitude of no greater than −45 dBm.
5. Program the instrument to internal and external FM off. Remove the spectrum analyzer. Reconnect the cable from A14J4 to A9J7.

3-31.2 Calibration. There are no calibration adjustments.

3-32. 20-MHz REFERENCE A14J3

3-32.1 Performance Check.

1. Remove the cable connected to A14J3. Connect frequency counter #5 to A14J3. Verify that the counter reads 20.0 MHz.
2. Remove the counter. Connect oscilloscope #11 to A14J3 using termination #18 at the input to the oscilloscope. Verify that the oscilloscope displays a stable 20-MHz signal with an amplitude of greater than 500 mV peak-to-peak.
3. Remove the oscilloscope. Reconnect the cable from A14J3 to A10J5.

3-32.2 Calibration. There are no calibration adjustments.

3-33. 10-MHz ECL REFERENCE A14J2

3-33.1 Performance Check.

1. Remove the cable connected to A14J2. Connect frequency counter #5 to A14J2. Verify that the counter reads 10.0 MHz.

2. Remove the counter. Connect oscilloscope #11 to A14J2. Verify that the oscilloscope displays a stable ECL-compatible signal (a negative level between −5.5 and −1.5 V, and a positive level between −0.9 and 0.0 V). Note: Ignore signal distortion due to the cable.

3. Remove the oscilloscope. Reconnect the cable from A14J2 to A10J4.

3-33.2 Calibration. There are no calibration adjustments.

3-34. 10-MHz TTL REFERENCE A14J1

3-34.1 Performance Check.

1. Remove the cable connected to A14J1. Connect frequency counter #5 to A14J1. Verify that the counter reads 10.0 MHz.

2. Remove the counter. Connect oscilloscope #11 to A14J1. Verify that the oscilloscope displays a stable TTL-compatible signal (a negative level between −0.6 and +0.6 V, and a positive level between +2.2 and +5.5 V).

3. Remove the oscilloscope. Reconnect the cable from A14J1 to A5A2J1.

3-34.2 Calibration. There are no calibration adjustments.

3-35. EXT TIMEBASE INPUT

3-35.1 Performance Check.

1. Program the instrument to 1000.000 MHz (CW) and power level to +7 dBm. Connect spectrum analyzer #8 to the RF output of the instrument.

2. Adjust the spectrum analyzer to display a 1000-MHz signal with the following settings:

   Input Atten.: 20 dB
   Ref. Level: +7 dBm
   Freq. Span/Div: 100 kHz

3. Verify a stable 1000-MHz signal.

4. Remove the cable from A14J7. This will make the 1000-MHz signal on the analyzer unstable (unlock).

5. Connect the timebase input on the rear panel of the instrument to a 1-MHz or 10-MHz external reference signal. Verify that the 1000-MHz signal on the analyzer is now stable (lock).

6. Reconnect the cable on A14J7. Remove the spectrum analyzer and the external reference signal.

3-35.2 Calibration. There are no calibration adjustments.

3-36. LOOP 7 AND DIVIDE-BY-Q A13, A12

3-36.1 Performance Check.

1. Remove A13 PC board from the instrument and reinstall using extenders. Connect an oscilloscope probe to the input of frequency counter #5 TP1.

2. Program the instrument to 475.000 000 MHz. Verify that the counter indicates 400.000 kHz.

3. Program the instrument to 1499.999 999 MHz. Verify that the counter indicates 799.950 kHz. Verify a voltage of +13.5 ±0.5 V.

4. Remove the counter and voltmeter. Reinstall the A13 PC board in the instrument. Reconnect the cable from A13J3 to A12J3.

3-36.2 Calibration.

1. If the requirements of paragraph 3-36.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A13 PC board from the instrument. Reinstall the A13 PC board using extenders.

3. Connect frequency counter #5 to TP1 using oscilloscope probe. Connect voltmeter #19 to TP9.

4. Program the instrument for 1499.999 999 MHz. Using tool #21, adjust A13L20 for a voltage of +13.5 V ±0.2 Vdc. Verify that the counter indicates 799.950 MHz.

5. Program the instrument for 475.000 000 MHz. Verify a voltage of 0.5 ±0.2 Vdc. Verify that the counter indicates 400.000 kHz. Repeat step 4 if necessary.

6. Remove the counter and voltmeter. Reinstall the A13 PC board in the instrument. Repeat paragraphs 3-36.1 and 3-36.2 if necessary. Reconnect cable from A13J3 to A12J3.

3-37. LOOP 6, A13 AND DIVIDE-BY-P, A11

3-37.1 Performance Check.

1. Using a SMB-T connector, connect A13J2, A11J3, and the frequency counter #5 to each port of the SMB-T connector.

2. Program the instrument to 475.000 000 MHz. Verify that the counter indicates 249.6 MHz.

3. Program the instrument to 1499.999 999 MHz. Verify that the counter indicates 399.2 MHz. Verify a voltage of +13.0 ±0.5 V.

4. Remove the SMB-T connector, counter, and voltmeter. Reinstall the A13 PC board in the instrument. Reconnect the cable from A13J2 to A11J3.

3-37.2 Calibration.

1. If the requirements of paragraph 3-37.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A13 PC board from the instrument. Reinstall the A13 PC board using extenders.

3. Using a SMB-T connector, connect A13J2, A11J3, and the frequency counter #5 to each port of the SMB-T connector.

4. Program the instrument for 1499.999 999 MHz. Using tool #21 adjust A13L19 for a voltage of +13.0 ±0.1 Vdc. Verify that the counter indicates 399.2 MHz.

5. Program the instrument for 1499.999 999 MHz. Verify a voltage of 2.0 ±0.5 V. Verify that the counter indicates 249.6 MHz. Repeat step 4 if necessary.

6. Remove the SMB-T connector, counter, and voltmeter. Reinstall the A13 PC board in the instrument. Repeat paragraph 3-37.1 and 3-37.2 if necessary.

3-38. LOOP 5, A13 AND DIVIDE-BY-Q, A12

3-38.1 Performance Check.

1. Remove A13 PC board from the instrument and reinstall using extenders. Remove the cable connected to A13J1. Connect frequency counter #5 to A13J1. Connect voltmeter #19 to TP2.

2. Program the instrument to 475.000 000 MHz. Verify that the counter indicates 250.000 000 MHz.

3. Program the instrument to 1499.999 999 MHz. Verify that the counter indicates 399.999 950 MHz. Verify a voltage of 0.0 V ±1.0 V. Reinstall the A13 PC board in the instrument.

4. Remove the counter. Reconnect the cable from A13J1 to A12J1. Remove the cable connected to A12J2. Connect the frequency counter #5 to A12J2.

5. Program the instrument to 475.000 000 MHz. Verify that the counter indicates 5.000 000 MHz.

6. Program the instrument to 1499.999 999 MHz. Verify that the counter indicates 7.999 999 MHz.

7. Remove the counter. Reconnect the cable from A12J2 to A7J2.

3-38.2 Calibration.

1. If the requirements of paragraph 3-38.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A13 PC board from the instrument. Reinstall the A13 PC board using extenders.
3. Remove the cable connected to A13J1. Connect frequency counter #5 to A13J1. Connect voltmeter #19 to TP2.
4. Program the instrument for 1499.999 999 MHz. Using tool #21 adjust A13L18 for 0 V ±0.1 Vdc. Verify that the counter indicates 399.999 950 MHz.
5. Program the instrument for 475.000 000 MHz. Verify a voltage between −2.0 to +2.0 Vdc. Verify that the counter indicates 250.000 000 MHz. Repeat step 4 if necessary.
6. Remove the counter and voltmeter. Reinstall the A13 PC board in the instrument. Repeat paragraph 3-38.1 and 3-38.2 if necessary.

3-39. LOOP 4, A10, DIVIDE-BY-N, A11, AND DIVIDE-BY-10, A10

3-39.1 Performance Check.

1. Remove A10 PC board from the instrument and reinstall using extenders. Connect frequency counter #5 to A10J2. Connect voltmeter #19 to TP3.
2. Program the instrument for 480.000 000 MHz. Verify that the counter indicates 25.0 MHz. Verify a voltage of +1.25 V ±0.5 V.
3. Program the instrument for 499.000 000 MHz. Verify that the counter indicates 44.0 MHz. Verify a voltage of +13.5 ±0.5 V.
4. Remove the counter and voltmeter. Reinstall A10 PC board in the instrument. Reconnect the cable from A10J2 to A9J3.

3-39.2 Calibration.

1. If the requirements of paragraph 3-38.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A10 PC board from the instrument. Reinstall the A10 PC board using extenders.
3. Connect frequency counter #5 to A10J2. Connect voltmeter #19 to TP3.
4. Program the instrument for 499.000 000 MHz. Using tool #21 adjust A10L6 for a voltage of +13.5 ±0.1 Vdc. Verify that the counter indicates 25.0 MHz.
5. Program the instrument for 480.000,000 MHz. Verify a voltage of 1.25 ±0.5 Vdc. Verify that the counter indicates 44.0 MHz.
6. Remove the counter and voltmeter. Reinstall the A10 PC board in the instrument. Repeat paragraphs 3-39.1 and 3-39.2 if necessary.
7. Reconnect the cable from A10J2 to A9J3.

3-40. LOOP 3, A10 AND 20 MHz COMB GENERATOR

3-40.1 Performance Check.

1. Remove A10 PC board from the instrument and reinstall using extenders.
2. Connect frequency counter #5 to A10J6. Connect oscilloscope #11 to TP2.
3. Install Jumper W2 #22. Verify the waveform displayed is symmetrical, about 0 V. Remove W2.
4. Program the instrument for 500.000 000 MHz. Verify that the counter indicates 240.0 MHz. Verify a voltage between +7.5 V and −7.5 V.
5. Program the instrument for 499.000,000 MHz. Verify that the counter indicates 500.0 MHz. Verify a voltage between +7.5 V and −7.5 V.

6. Remove the counter and oscilloscope. Reinstall A10 PC board in the instrument. Reconnect the cable from A10J6 to A9J4.

3-40.2 Calibration.

1. If the requirements of paragraph 3-40.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A10 PC board from the instrument. Reinstall the A10 PC board using extenders.
3. Remove the cable connected to A10J6. Connect frequency counter #5 to A10J6. Connect oscilloscope #11 to TP2. Install Jumper W2 #22.
4. Program the instrument for 380.000 000 MHz. Adjust A10R25 for a symmetrical waveform about 0 V. Remove W2. Adjust A10L5 for 0 V ±1.0 Vdc level. Verify the counter indicates 400.0 MHz.
5. Program the instrument for 500.000 000 MHz. Verify the counter indicates 240.0 MHz. Verify a voltage level between +7.5 V and −7.5 V.
6. Program the instrument for 499.000 000. Verify the counter indicates 500.0 MHz. Verify a voltage level between +7.5 V and −7.5 V.
7. Remove the frequency counter and oscilloscope. Reinstall the A10 PC board in the instrument. Replace the cable between A10J6 and A9J4. Repeat paragraphs 3-40.1 and 3-40.2 if necessary.

3-41. LOOP 2, A9

3-41.1 Performance Check.

1. Remove A9 PC board from the instrument. Reinstall using extenders.
2. Connect frequency counter #5 to A9J2. Connect voltmeter #19 to A9TP2.
3. Program the instrument for 499.000 ,000 MHz. Verify that the counter indicates 544.0 MHz. Verify a voltage between +2.0 V and −2.0 V.
4. Program the instrument for 500.000 000 MHz. Verify that the counter indicates 272.0 MHz. Verify a voltage between +5.0 V and −5.0 V.

3-41.2 Calibration.

1. If the requirements of paragraph 3-41.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A9 PC board from the instrument. Reinstall the A9 PC board using extenders.
3. Connect frequency counter #5 to A9J2. Connect voltmeter #19 to A9TP2.
4. Program the instrument for 499.000 000 MHz. Using tool #21 adjust A9L3 for −1.0 V to +1.0 Vdc. Verify that the counter indicates 544.0 MHz.
5. Program the instrument for 500.000,000 MHz. Verify a voltage between −5.0 V to +5.0 Vdc. Verify that the counter indicates 272.0 MHz. Repeat step 4 as necessary.
6. Remove the counter and voltmeter. Reinstall the A9 PC board in the instrument. Repeat paragraph 3-41.1.

3-42. LOOP 9 AND DIVIDE-BY-2 A9, A12

3-42.1 Performance Check.

1. Remove the A9 PC board from the instrument and reinstall using extenders.
2. Connect frequency counter #5 to A12J5. Connect voltmeter #19 to A9TP4.
3. Program the instrument for external FM ON, DC-coupled. Verify that the counter indicates 50 MHz ±0.1 MHz. Verify a voltage of 3.2 V ±0.2 Vdc.

4. Program the instrument for external FM ON, AC-coupled. Verify that the counter indicates 50.000 000 MHz. Verify a voltage of 3.2 V ±0.2 Vdc.

5. Remove the voltmeter and counter. Connect the RF input of measuring receiver #15 to the RF output of the instrument.

6. Set the measuring receiver as follows:

Measurement:	FM
Detector:	Peak ±/2
Filters:	None

7. Program the instrument to 1 GHz, internal FM on, FM rate 1 kHz.

8. For the list of deviations in step 9, program the instrument to the selected deviation. Verify the measuring receiver indicates the selected deviation ±7%.

9. List of deviations:

   9.99 kHz
   99.9 kHz
   100 kHz

10. Connect audio generator #16 to the instruments FM input connector. Adjust the audio generator for an output signal of 1 kHz, 0.707 V rms.

11. Program the instrument to INT FM OFF, EXT FM ON, 100 kHz/V FM sensitivity. Verify the measuring receiver indicates 100-kHz deviation ±7%.

12. Remove the measuring receiver. Reinstall the A9 PC board in the instrument. Reconnect cable to A12J5.

3-42.2 Calibration.

1. If the requirements of paragraph 3-42.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A9 PC board from the instrument and reinstall using extenders.

3. Remove cable connected to A12J5. Connect frequency counter #5 to A12J5. Connect voltmeter to A9TP4.

4. Program the instrument for external FM on, DC-coupled. Using tool #21, adjust A9L11 until the frequency counter indicates 50.000 ±50 kHz.

5. Program the instrument to external FM on, AC-coupled. Verify that the frequency counter indicates 50.000 MHz and A9TP4 is 3.2 V ±0.2 Vdc.

6. Remove the voltmeter and counter. Connect the RF input of measuring receiver #15 to the RF output of the instrument and reconnect A12J5.

7. Set the measuring receiver as follows:

Measurement:	FM
Detector:	Peak ±/2
Filters:	None

8. Program the instrument to 1 GHz, internal FM on, FM rate 1 kHz, FM deviation 25.0 kHz.

9. Adjust A9R81 for an indication of 25.0 kHz.

10. For deviations of 99.9 kHz and 100 kHz program the instrument to the selected deviation. Verify the modulation analyzer indicates the selected deviation ±7%.

11. Connect audio generator #16 to the instrument's FM input connector. Adjust the audio generator for an output signal of 1 kHz, 0.707 V rms.

12. Program the instrument to INT FM off, EXT FM on, 100 kHz/V FM sensitivity. Verify the measuring receiver indicates 100 kHz ±7%.

13. Remove the measuring receiver. Reinstall the A9 PC board in the instrument.

3-43. LOOP 1 IF, A8

3-43.1 Performance Check.

1. Remove the A8 PC board from the instrument and reinstall using extenders. Remove cables from A7J2, A7J3, A7J5, and A8J4.

2. Connect frequency counter #5 to A7J5. Connect power supply #4 to A7J3 and adjust the power supply voltage to 3.3 V nominal.

3. Connect spectrum analyzer #8 to A8TP2 using oscilloscope probe with ground clip.

4. Adjust the spectrum analyzer for a center frequency of 82 MHz, a span of 10 MHz/div, 10-dB input attenuation reference level of −20 dBm, 10 dB/div.

5. Program the instrument to 440 MHz. Adjust the power supply for a frequency counter indication of 403 MHz ±1 MHz.

6. Manually sweep the signal around this frequency by fine tuning the power supply voltage and verify that the signal displayed on the spectrum analyzer is a minimum of 82 MHz.

7. Adjust the spectrum analyzer for a center frequency of 56 MHz.

8. Adjust the power supply for a frequency counter indication of 429 MHz ±1 MHz.

9. Manually sweep the signal around this frequency by fine tuning the power supply voltage and verify that the signal displayed is a minimum at 56 MHz.

3-43.2 Calibration.

1. If the requirements of paragraph 3-43.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Connect frequency counter #5 to A7J5. Connect power supply #4 to A7J3 and adjust the power supply voltage to 3.3 V nominal.

3. Connect spectrum analyzer #8 to A8TP2 using oscilloscope probe with ground clip.

4. Adjust the spectrum analyzer for a center frequency of 82 MHz, a span of 10 MHz/div, 10-dB input attenuation reference level of −20 dBm, 10 dB/div.

5. Program the instrument to 440 MHz. Adjust the power supply for a frequency counter indication of 403 MHz ±1 MHz.

6. Manually sweep the signal around this frequency by fine tuning the power supply voltage. Adjust A8L7 for a minimum signal at 82 MHz.

7. Adjust the spectrum analyzer for a center frequency of 56 MHz.

8. Adjust the power supply for a frequency counter indication of 429 MHz ±1 MHz.

9. Manually sweep the signal around this frequency by fine tuning the power supply voltage. Adjust A8L2 for a minimum signal at 56 MHz.

10. Repeat steps 4 through 9 until no further adjustment is required.

11. Remove the spectrum analyzer and oscilloscope probe, frequency counter and power supply. Reinstall the A8 PC board in the instrument. Reconnect cables to A7J2, A7J3, A7J5, and A8J4.

3-44. LOOP 1, A7

3-44.1 Performance Check.

1. Connect spectrum analyzer #8 to A7J5. Adjust the analyzer to display signals from 250 to 1500 MHz.

2. Program the instrument to sweep from 250 to 1500 MHz at 10-MHz steps with a 10 ms sweep time.

3. Verify that the amplitude of the signals displayed on the analyzer is greater than +3 dBm.

4. Remove spectrum analyzer. Reconnect the cable to A7J5.

5. Remove the cable to A7J4 and connect the spectrum analyzer #8 to A7J4. Adjust the

spectrum analyzer to display signals from 250 to 1500 MHz.

6. Program the instrument to sweep from 250 to 1499 MHz at 10-MHz steps with 10 ms sweep time.

7. Verify that the amplitude of the signals displayed on the analyzer is greater than −18 dBm.

8. Remove the spectrum analyzer. Reconnect the cable to A7J4.

3-44.2 Calibration. There are no calibration adjustments.

3-45. LOOP 1, 250 TO 500 MHz OSCILLATOR, A7

3-45.1 Performance Check.

1. Remove A7 PC board from instrument and reinstall using extenders.

2. Connect frequency counter #5 to A7J5 and voltmeter #19 to A7TP5.

3. Program the instrument for 250.000 000 MHz. Verify a frequency of 250.000,000 MHz and a voltage between −5.0 and +5.0 V.

4. Program the instrument for 499.999 999 MHz. Verify a frequency of 499.999 999 MHz and a voltage between −5.0 V and +5.0 V.

5. Remove the counter and voltmeter. Reinstall A7 PC board in instrument. Reconnect the cable from A7J5 to A22J2.

3-45.2 Calibration.

1. If the requirements of paragraph 3-45.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A7 PC board from the instrument and reinstall using extenders.

3. Remove the cable connected to A7J5. Connect frequency counter #5 to A7J5.

4. Program the instrument for 499.999 999 MHz. Connect voltmeter #19 to A7TP5. Using tool #21 adjust A7L5 for a voltage between −1.0 Vdc to +1.0 Vdc. Verify that the counter indicates 499.999 999 MHz.

5. Program the instrument for 250.000 000 MHz. Verify a voltage between −5 Vdc to +5 Vdc. Verify that the counter indicates 250.000 000 MHz. Repeat step 4 if necessary.

6. Remove the counter and voltmeter. Reinstall the A7 PC board in the instrument. Reconnect the cable from A7J5 to A22J2. Repeat paragraphs 3-45.1 and 3-45.2 as necessary.

7. If requirements of paragraph 3-45.1 are not met after calibration, oscillator coarse tune voltage calibration at the factory may be necessary for new EEPROM data, or a FAILURE exists and instrument repair is required.

3-46. LOOP 1, 500 TO 1000 MHz OSCILLATOR, A7

3-46.1 Performance Check.

1. Remove A7 PC board from instrument and reinstall using extenders.

2. Remove the cable connected to A7J5 and connect frequency counter #5 to A7J5 and voltmeter #19 to A7TP5.

3. Program the instrument for 500.000 000 MHz. Verify a frequency of 500.000 000 MHz and a voltage between −5.0 V and +5.0 V.

4. Program the instrument for 999.999 999 MHz. Verify a frequency of 999.999 999 MHz and a voltage between −5.0 V and +5.0 V.

5. Remove the counter and voltmeter. Reinstall A7 PC board in instrument. Reconnect the cable from A7J5 to A22J2.

3-46.2 Calibration.

1. If the requirements of paragraph 3-46.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A7 PC board from the instrument and reinstall using extenders.

3. Remove the cable connected to A7J5. Connect frequency counter #5 to A7J5.

4. Program the instrument for 499.999 999 MHz. Connect voltmeter #19 to A7TP5. Using tool #21 adjust A7L5 for a voltage between −1.0 Vdc to +1.0 Vdc. Verify that the counter indicates 499.999 999 MHz.

5. Program the instrument for 500.000 000 MHz. Verify a voltage between −5.0 Vdc to +5.0 Vdc. Verify that the counter indicates 500.000 000 MHz. Repeat step 4 if necessary.

6. Remove the counter and voltmeter. Reinstall the A7 PC board in the instrument. Reconnect the cable from A7J5 to A22J2. Repeat paragraphs 3-46.1 and 3-46.2 as necessary.

7. If requirements of paragraph 3-46.1 are not met after calibration, oscillator coarse tune voltage calibration at the factory may be necessary for new EEPROM data, or a FAILURE exists and instrument repair is required.

3-47. LOOP 1, 1000 TO 1500 MHz OSCILLATOR, A7

3-47.1 Performance Check.

1. Remove A7 PC board from instrument and reinstall using extenders.

2. Remove the cable connected to A7J5 and connect frequency counter #5 to A7J5 and voltmeter #19 to A7TP5.

3. Program the instrument for 1000.000 000 MHz. Verify a frequency of 1000.000 000 MHz and a voltage between −5.0 V and +5.0 V.

4. Program the instrument for 1499.999 999 MHz. Verify a frequency of 1499.999 999 MHz and a voltage between −5.0 V and +5.0 V.

5. Remove the counter and voltmeter. Reinstall A7 PC board in the instrument. Reconnect the cable from A7J5 to A22J2.

3-47.2 Calibration.

1. If the requirements of paragraph 3-47.1 are met, adjustments are not required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A7 PC board from the instrument. Reinstall the A7 PC board using extenders.

3. Remove the cable connected to A7J5. Connect frequency counter #5 to A7J5.

4. Program the instrument for 1499.999 999 MHz. Connect voltmeter #19 to A7TP5. Using tool #21, adjust A7C60 for a voltage between −1.0 V and +1.0 V. Verify that the counter indicates 1499.999 999 MHz.

5. Program the instrument for 1000.000 000 MHz. Verify a voltage between −5 Vdc and +5 Vdc. Verify that the counter indicates 1000.000 000 MHz. Repeat step 4 if necessary.

6. Remove the counter and voltmeter. Reinstall the A7 PC board in the instrument. Reconnect the cable from A7J5 to A22J2. Repeat paragraph 3-47.1.

3-48. DOWNCONVERTER, A6

3-48.1 Performance Check.

1. Program the instrument for 100.000 000 MHz.

2. Remove the coax connected to A6J3. Connect spectrum analyzer #8 to A6J3.

3. Tune the spectrum analyzer to 100.000 MHz and verify a stable signal with RF level not less than +18 dBm.

4. Program the instrument for 249.000 MHz.

5. Tune the spectrum analyzer to 249.000 MHz and verify a stable signal with RF level not less than +18 dBm.

6. Remove the spectrum analyzer and reconnect the cable from A6J3.

3-48.2 800 MHz Oscillator, Loop 8, A6 — Performance Check.

1. Remove A6 PC board from instrument and reinstall using extenders.

2. Connect the frequency counter #5 to A6J4 and voltmeter #19 to A6TP1.

3. Program the instrument for 100.000 MHz. Verify a frequency of 800.000 MHz and a voltage between 4.5 and 5.5 Vdc.

4. Remove the frequency counter and voltmeter. Reinstall A6 PC board in instrument.

3-48.3 Calibration.

1. If the requirements of paragraphs 3-48.1 and 3-48.2 are met, no adjustments are required.

NOTE

Prior to performing calibration procedure, review Precautions paragraph 3-25.3.

Components face to rear of instrument.

2. Remove the A6 PC board from the instrument and reinstall using extenders.

3. Connect frequency counter #5 to A6J4. Connect voltmeter to A6TP1.

4. Program the instrument for 100.000 MHz. Using tool #21 adjust C57 for a voltage of 5.0 ±0.2 Vdc. Verify that the counter indicates 800.000 000 MHz.

5. Remove the counter and voltmeter. Reinstall A6 PC board in the instrument.

3-49. LEVEL CONTROL LOOP (A4 AND OUTPUT MODULE)

3-49.1 Performance Check.

1. Connect measuring receiver #15 directly to the instrument's RF output connector.

2. Program the instrument for a frequency of 1000.000 MHz. Program the instrument to an RF output level of +13.0 dBm.

3. Adjust the measuring receiver to indicate RF power at 1000 MHz. Verify an output level of +13.0 dBm ±1.0 dB.

4. Program the instrument for an RF output level of −2.9 dBm. Verify that the measured RF level is −2.9 dBm ±1 dB.

5. Program the instrument for an RF output level of 5 dBm. Step the instrument from 10 to 1499 MHz or 2500 MHz (model 1502) in 20 MHz steps. Verify that the RF level stays within ±1.0 dB.

3-49.2 Calibration.

1. If the requirements of paragraph 3-49.1 are met, adjustments are not required.

NOTE

This procedure assumes an ambient temperature of 15° to 35°C and adequate warmup time for the instrument.

2. The top cover of the instrument should be replaced (attaching screws not necessary) when verifying the RF level in this procedure. When making the adjustments in the step below, remove the cover only long enough to make the adjustment. Replace the cover and wait at least 1 minute before verifying the RF level.

3. Connect measuring receiver #15 directly to the instrument's RF output connector.

4. Program the instrument for a frequency of 1000.000 MHz.

5. Program the instrument to an RF output of −2.9 dBm. Adjust A23R71 for an RF output of −2.9 dBm ±0.2 dB.

6. Program the instrument to an RF output of +13.0 dBm. Adjust A23R77 for an RF output of 13.0 dBm ±0.02 dB.

7. Repeats steps 5 and 6 as necessary until no further adjustment is required.

NOTE

If requirements of paragraph 3-49.1 are not met after calibration, level calibration at the factory may be necessary for new PROM data, or a FAILURE exists and instrument repair is required.

8. Remove the measuring receiver from the instrument. Repeat paragraph 3-49.1.

3-50. AMPLITUDE MODULATION, A4

3-50.1 Performance Check.

NOTE

Correct RF level calibration is a prerequisite for this procedure.

1. Connect measuring receiver #15 to the instrument's RF output connector. Set the measuring receiver to indicate AM depth.

2. Program the instrument for 1000.000 MHz. Program the instrument for an RF output level of +7.0 dBm with an internal AM rate of 1000 Hz and an AM depth of 30%. Verify that the measuring receiver indicates an AM depth of 28.2% to 31.8%. Verify that the distortion is no greater than 2%.

3. Program the instrument for an RF output level of −2.9 dBm with an internal AM rate of 1000 Hz and an AM depth of 70%. Verify that the measuring receiver indicates an AM depth of 65.8% to 74.2%. Verify that the distortion is no greater than 4%.

4. Program the instrument for an RF output level of +7.0 dBm with an internal AM rate of 1000 Hz and an AM depth of 90.0%. Verify that the measuring receiver indicates an AM depth of 84.6% to 95.4%. Verify that the distortion is no greater than 6%.

NOTE

External AM sensitivity is 1.0 mV peak per 0.1% AM. Any error in the amplitude setting of the audio generator will produce a corresponding error in the external AM depth.

30% AM depth requires a 300 mV peak input. 70% AM depth requires a 700 mV peak input. 90.0% AM depth requires a 900 mV peak input.

5. Repeat steps 2 through 4 for external AM, with an external AM input from audio generator #16.

3-50.2 Calibration.

1. If the requirements of paragraph 3-50.1 are met, no adjustments are necessary.

2. Connect measuring receiver #15 to the instrument's RF output connector. Set the measuring receiver to indicate AM depth.

3. Program the instrument for 1000.000 MHz. Program the instrument for an RF output level of −2.9 dBm.

4. Program the instrument to internal AM, rate of 1000 Hz, and AM depth of 90%. Adjust the measuring receiver to indicate AM +peak. Adjust A4R6 (CAL INT AM) for an AM depth of 90.0% as indicated on the measuring receiver.

5. Adjust the measuring receiver to indicate AM −peak. Adjust A23R97 for an AM depth of 90.0% as indicated on the measuring receiver.

6. Repeat steps 4 and 5 until no further adjustment is required.

NOTE

External AM sensitivity is 1.0 mV peak per 0.1% AM. Any error in the amplitude setting of the audio generator will produce a corresponding error in the external AM depth.

7. Program instrument to external AM on and internal AM off. Connect audio generator #16

to the instrument's external AM input connector. Adjust the audio generator for a frequency of 1000 Hz and an amplitude of 900 mV peak.

8. Adjust the measuring receiver to indicate AM +peak. Adjust A4R7 (CAL EXT AM) for an AM depth of 90.0% as indicated on the measuring receiver.

9. Remove the measuring receiver and audio generator.

3-51. This completes the alignment procedures. If, in any of the procedures above, it is impossible to obtain the specified results, a FAILURE exists and instrument repair is required.

3-52. If instrument performance is as described above, calibration is completed. Reinstall the instrument top cover.

3-53. TROUBLESHOOTING

3-53.1 The troubleshooting flowcharts provided as part of this paragraph are intended to provide the technician with guidelines for instrument troubleshooting in the event an instrument error code, i.e. E4.4, is displayed. In most cases, these flowcharts should prove sufficient to permit rapid isolation of instrument faults to a single circuit board.

3-53.2 The following chart lists the error indexed to the appropriate troubleshooting flowchart figure number:

Error Code	Figure Number	Error Code	Figure Number
4.1	3-1	10.2	3-11
4.2	3-1	11.1	3-12
4.3	3-2	11.2	3-13
4.4	3-3	12.1	3-14
5.1	3-4	12.2	3-15
6.2	3-5	13.2	3-16
7.1	3-6	13.3	3-18
9.1	3-7	14.1	3-19
9.2	3-8	14.2	3-20
9.3	3-9	23.1	3-21
10.1	3-10		

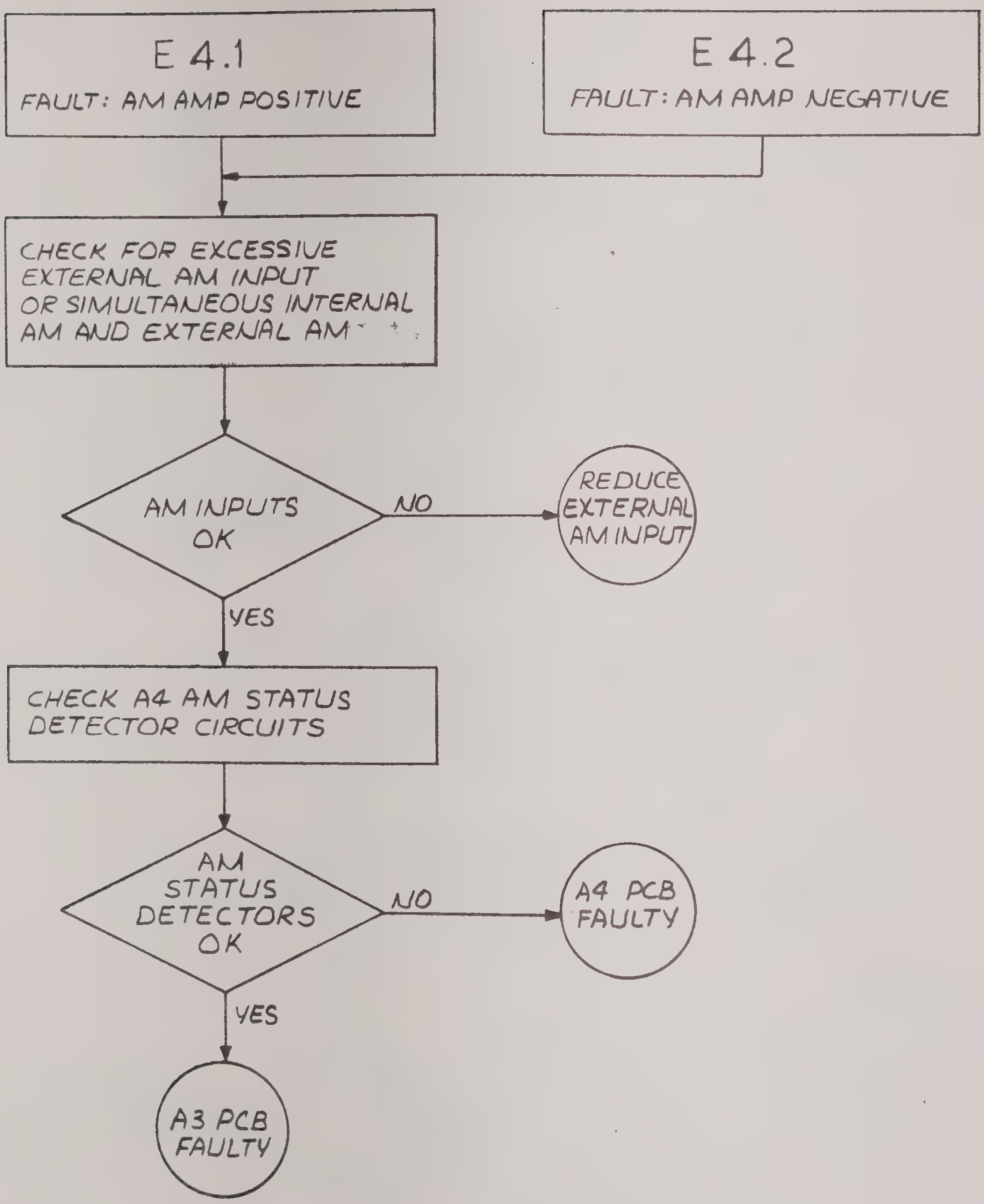

E 4.1
FAULT: AM AMP POSITIVE
E 4.2
FAULT: AM AMP NEGATIVE
CHECK FOR EXCESSIVE EXTERNAL AM INPUT OR SIMULTANEOUS INTERNAL AM AND EXTERNAL AM
AM INPUTS OK
NO
REDUCE EXTERNAL AM INPUT
YES
CHECK A4 AM STATUS DETECTOR CIRCUITS
AM STATUS DETECTORS OK
NO
A4 PCB FAULTY
YES
A3 PCB FAULTY

Figure 3-1. Troubleshooting Flowchart — Error Codes 4.1 and 4.2

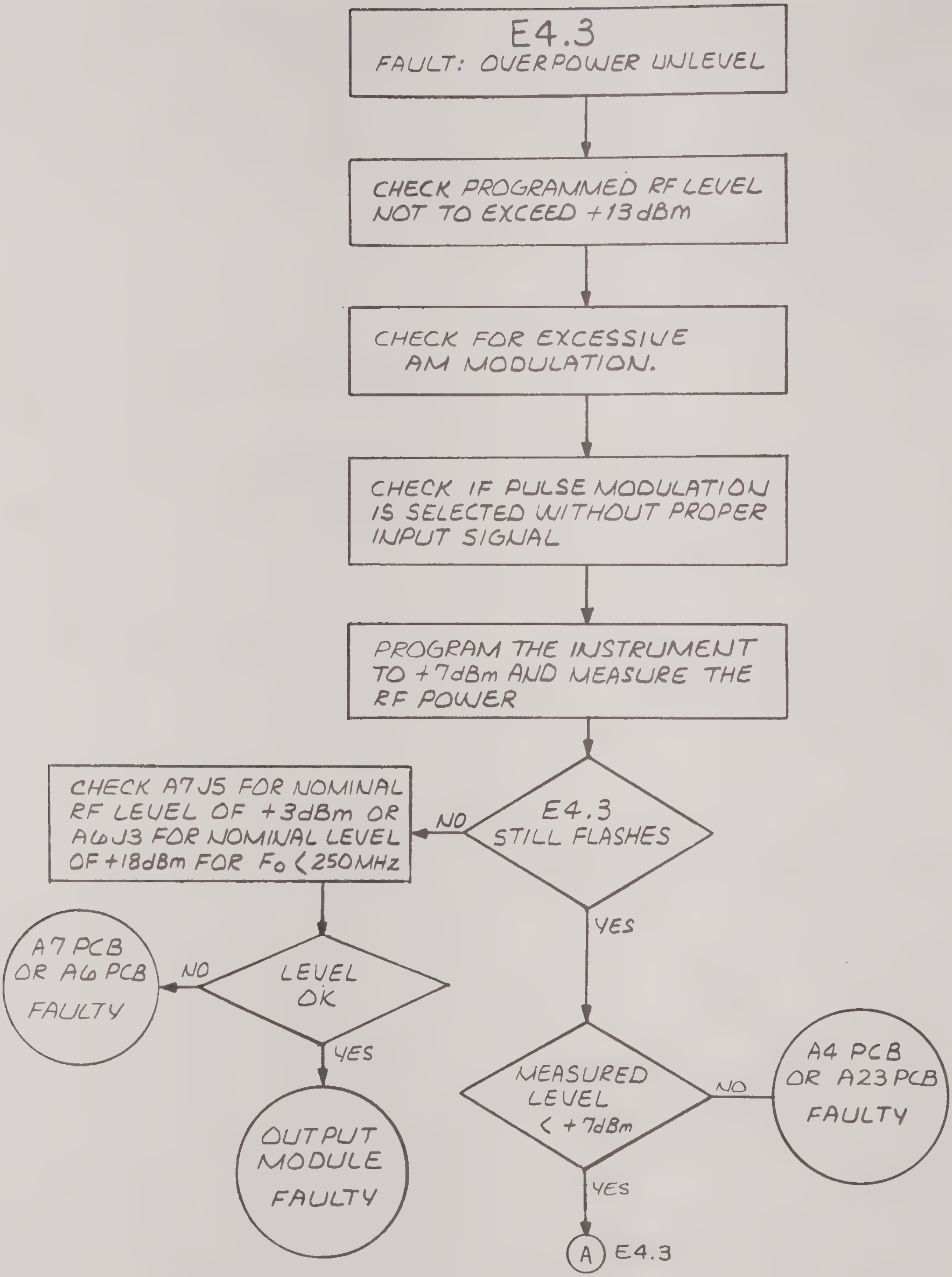

E4.3
FAULT: OVERPOWER UNLEVEL
CHECK PROGRAMMED RF LEVEL NOT TO EXCEED +13dBm
CHECK FOR EXCESSIVE AM MODULATION.
CHECK IF PULSE MODULATION IS SELECTED WITHOUT PROPER INPUT SIGNAL
PROGRAM THE INSTRUMENT TO +7dBm AND MEASURE THE RF POWER
E4.3 STILL FLASHES
NO
CHECK A7J5 FOR NOMINAL RF LEVEL OF +3dBm OR A6J3 FOR NOMINAL LEVEL OF +18dBm FOR F₀ < 250MHz
LEVEL OK
NO
A7 PCB OR A6 PCB FAULTY
YES
OUTPUT MODULE FAULTY
YES
MEASURED LEVEL < +7dBm
NO
A4 PCB OR A23 PCB FAULTY
YES
A
E4.3

Figure 3-2. Troubleshooting Flowchart — Error Code 4.3 (Sheet 1 of 4)

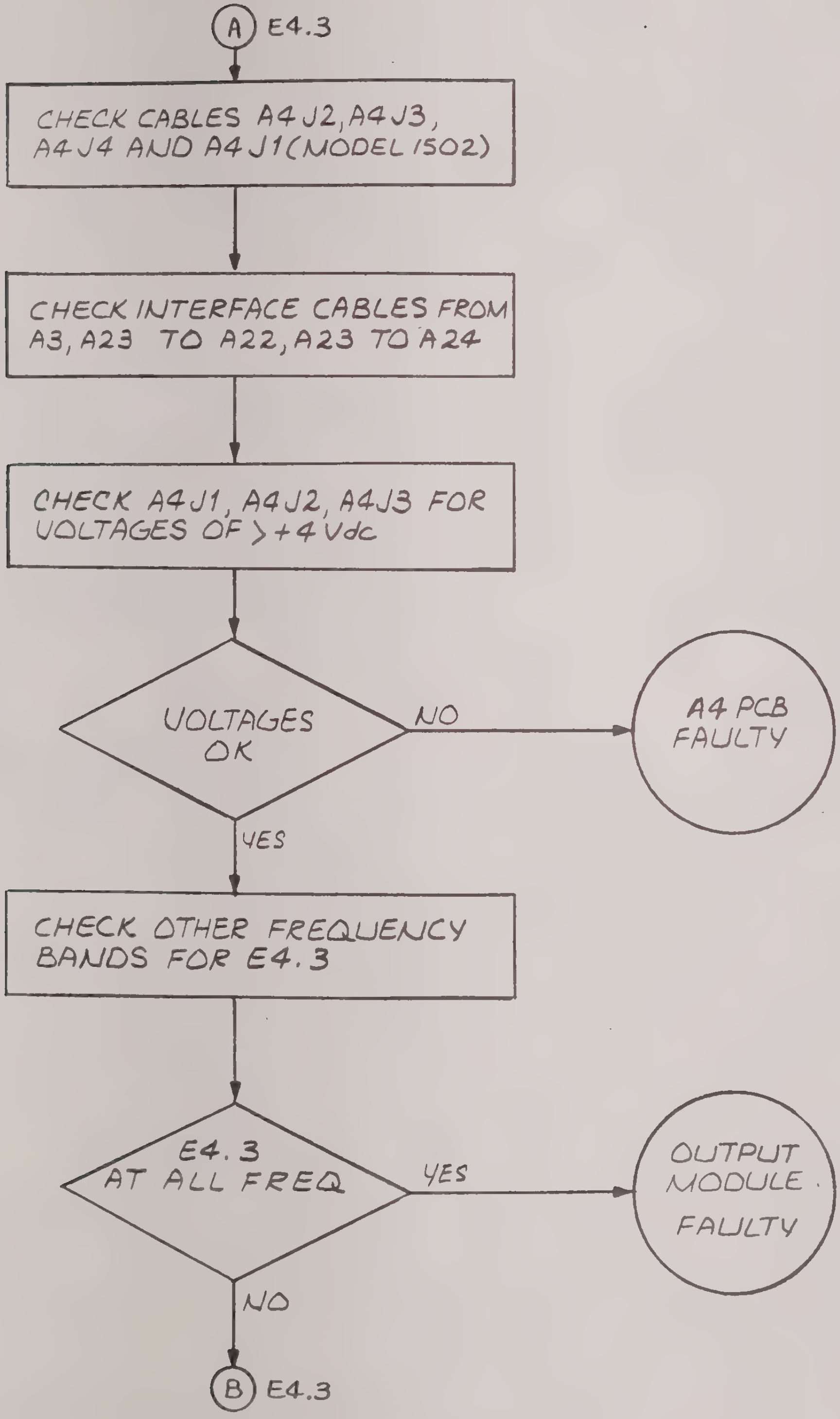

A E4.3
CHECK CABLES A4J2, A4J3, A4J4 AND A4J1 (MODEL 1502)
CHECK INTERFACE CABLES FROM A3, A23 TO A22, A23 TO A24
CHECK A4J1, A4J2, A4J3 FOR VOLTAGES OF > +4 Vdc
VOLTAGES OK
NO
A4 PCB FAULTY
YES
CHECK OTHER FREQUENCY BANDS FOR E4.3
E4.3 AT ALL FREQ
YES
OUTPUT MODULE FAULTY
NO
B E4.3

Figure 3-2. Troubleshooting Flowchart — Error Code 4.3 (Sheet 2 of 4)

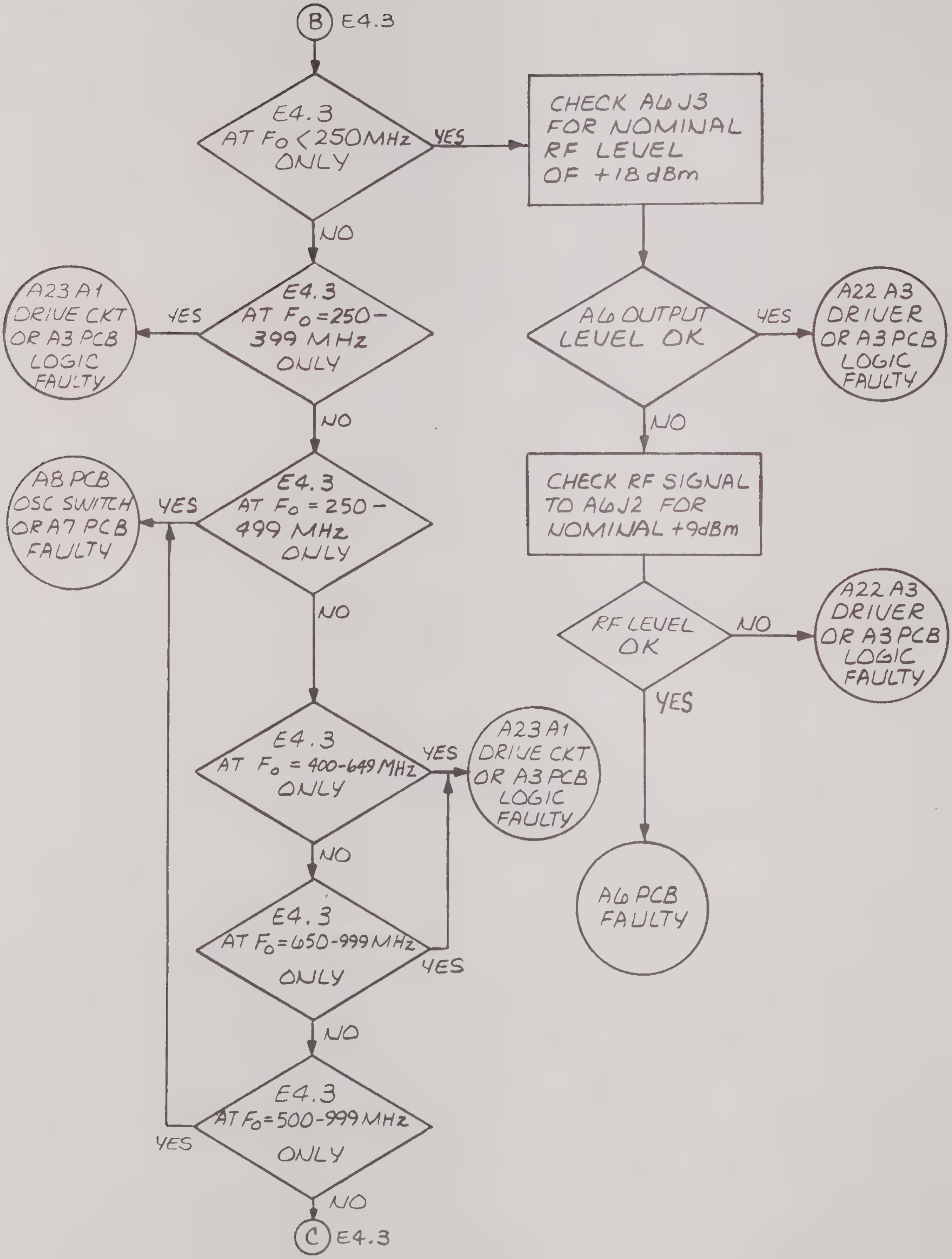

B E4.3
E4.3 AT F0 <250MHz ONLY
YES
CHECK A6 J3 FOR NOMINAL RF LEVEL OF +18 dBm
NO
E4.3 AT F0 =250-399 MHz ONLY
YES
A23 A1 DRIVE CKT OR A3 PCB LOGIC FAULTY
A6 OUTPUT LEVEL OK
YES
A22 A3 DRIVER OR A3 PCB LOGIC FAULTY
NO
NO
E4.3 AT F0 = 250-499 MHz ONLY
YES
A8 PCB OSC SWITCH OR A7 PCB FAULTY
CHECK RF SIGNAL TO A6 J2 FOR NOMINAL +9dBm
RF LEVEL OK
NO
A22 A3 DRIVER OR A3 PCB LOGIC FAULTY
NO
YES
E4.3 AT F0 = 400-649 MHz ONLY
YES
A23 A1 DRIVE CKT OR A3 PCB LOGIC FAULTY
NO
A6 PCB FAULTY
E4.3 AT F0=650-999 MHz ONLY
YES
NO
E4.3 AT F0=500-999 MHz ONLY
YES
NO
C E4.3

Figure 3-2. Troubleshooting Flowchart — Error Code 4.3 (Sheet 3 of 4)

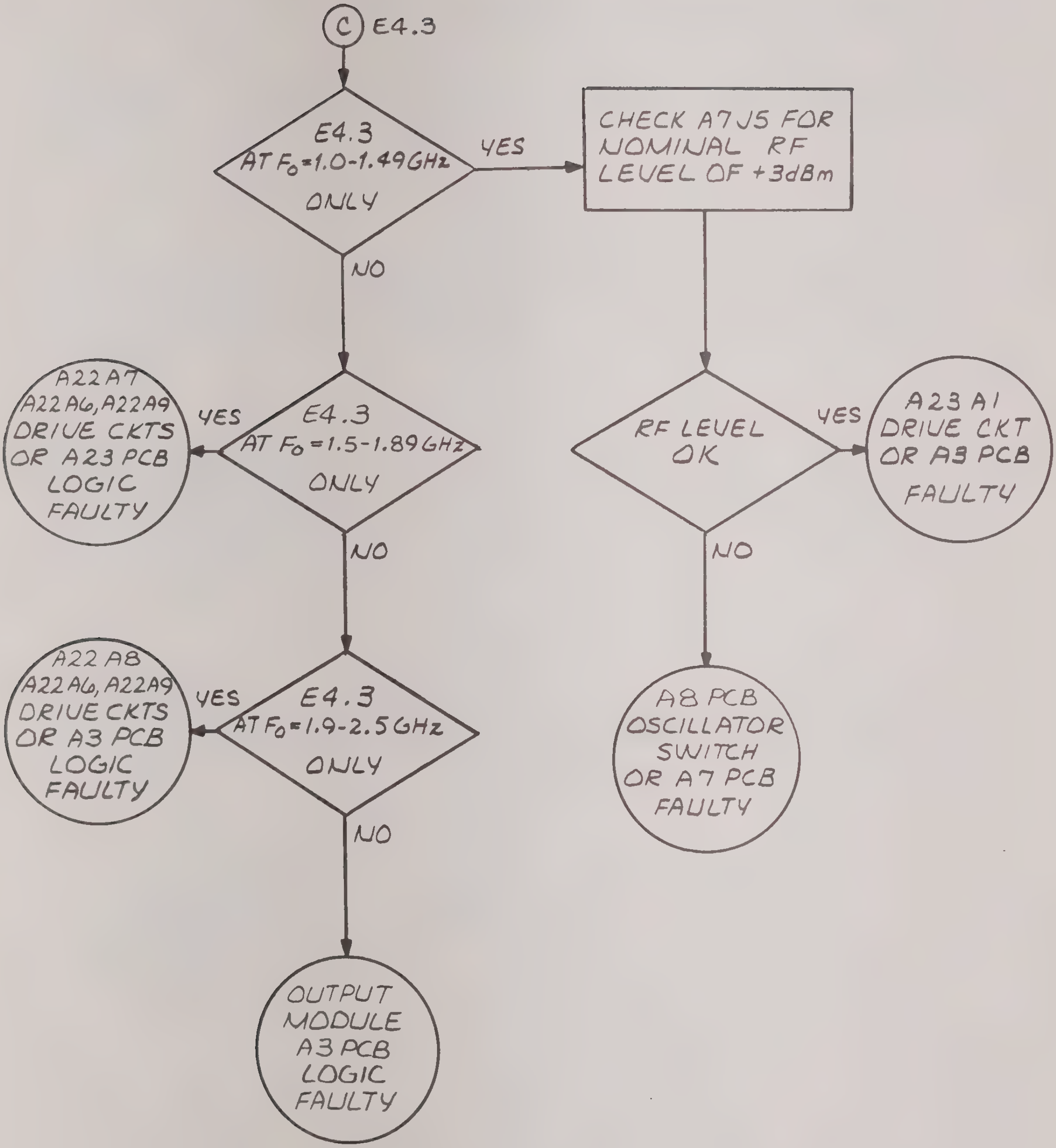

C E4.3
E4.3 AT F₀=1.0-1.49GHz ONLY
YES
CHECK A7J5 FOR NOMINAL RF LEVEL OF +3dBm
NO
A22A7 A22A6, A22A9 DRIVE CKTS OR A23 PCB LOGIC FAULTY
YES
E4.3 AT F₀=1.5-1.89GHz ONLY
RF LEVEL OK
YES
A23 A1 DRIVE CKT OR A3 PCB FAULTY
NO
NO
A22 A8 A22A6, A22A9 DRIVE CKTS OR A3 PCB LOGIC FAULTY
YES
E4.3 AT F₀=1.9-2.5GHz ONLY
A8 PCB OSCILLATOR SWITCH OR A7 PCB FAULTY
NO
OUTPUT MODULE A3 PCB LOGIC FAULTY

Figure 3-2. Troubleshooting Flowchart — Error Code 4.3 (Sheet 4 of 4)

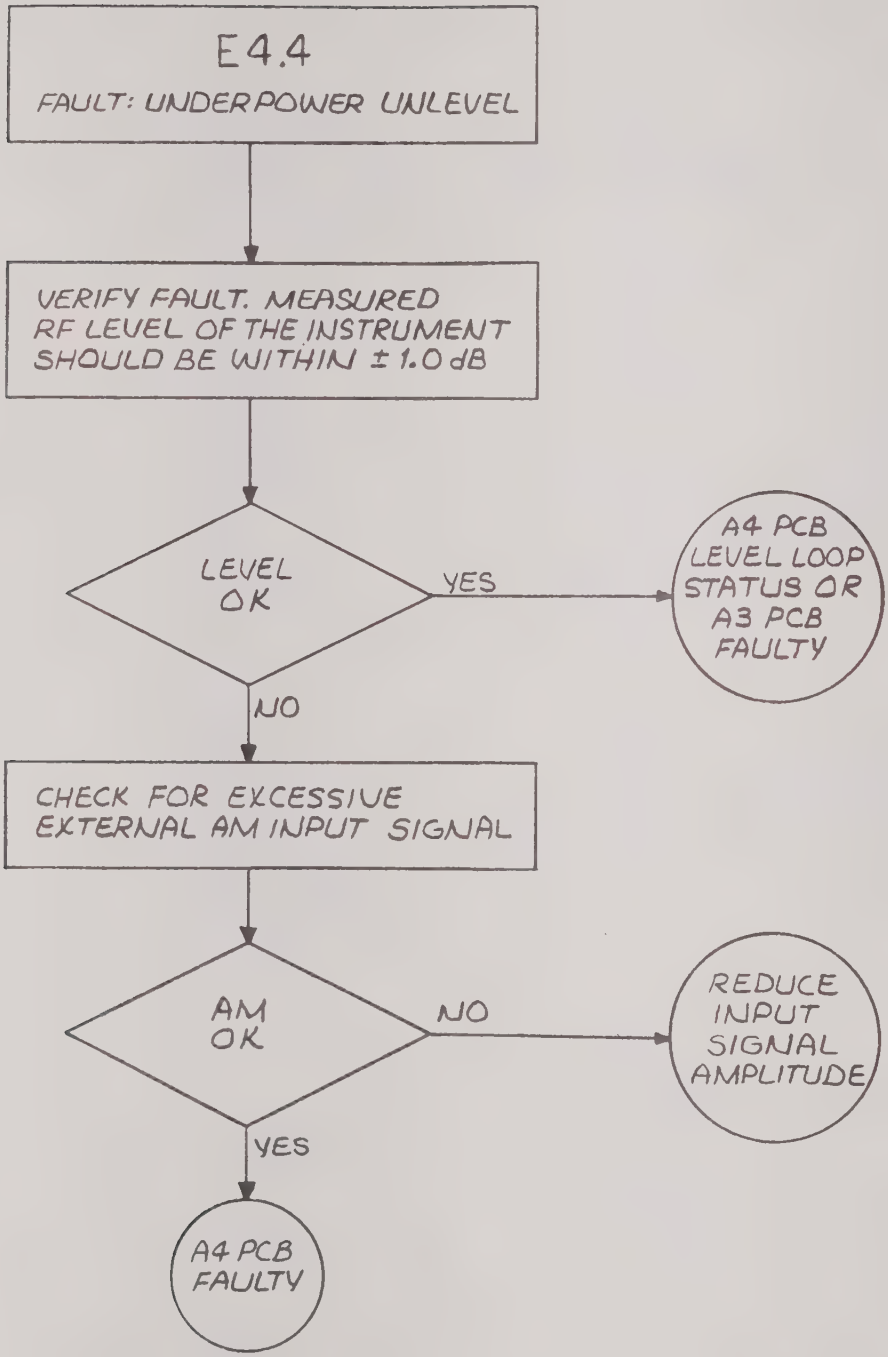

E4.4
FAULT: UNDERPOWER UNLEVEL
VERIFY FAULT. MEASURED RF LEVEL OF THE INSTRUMENT SHOULD BE WITHIN ± 1.0 dB
LEVEL OK
YES
A4 PCB LEVEL LOOP STATUS OR A3 PCB FAULTY
NO
CHECK FOR EXCESSIVE EXTERNAL AM INPUT SIGNAL
AM OK
NO
REDUCE INPUT SIGNAL AMPLITUDE
YES
A4 PCB FAULTY

Figure 3-3. Troubleshooting Flowchart — Error Code 4.4

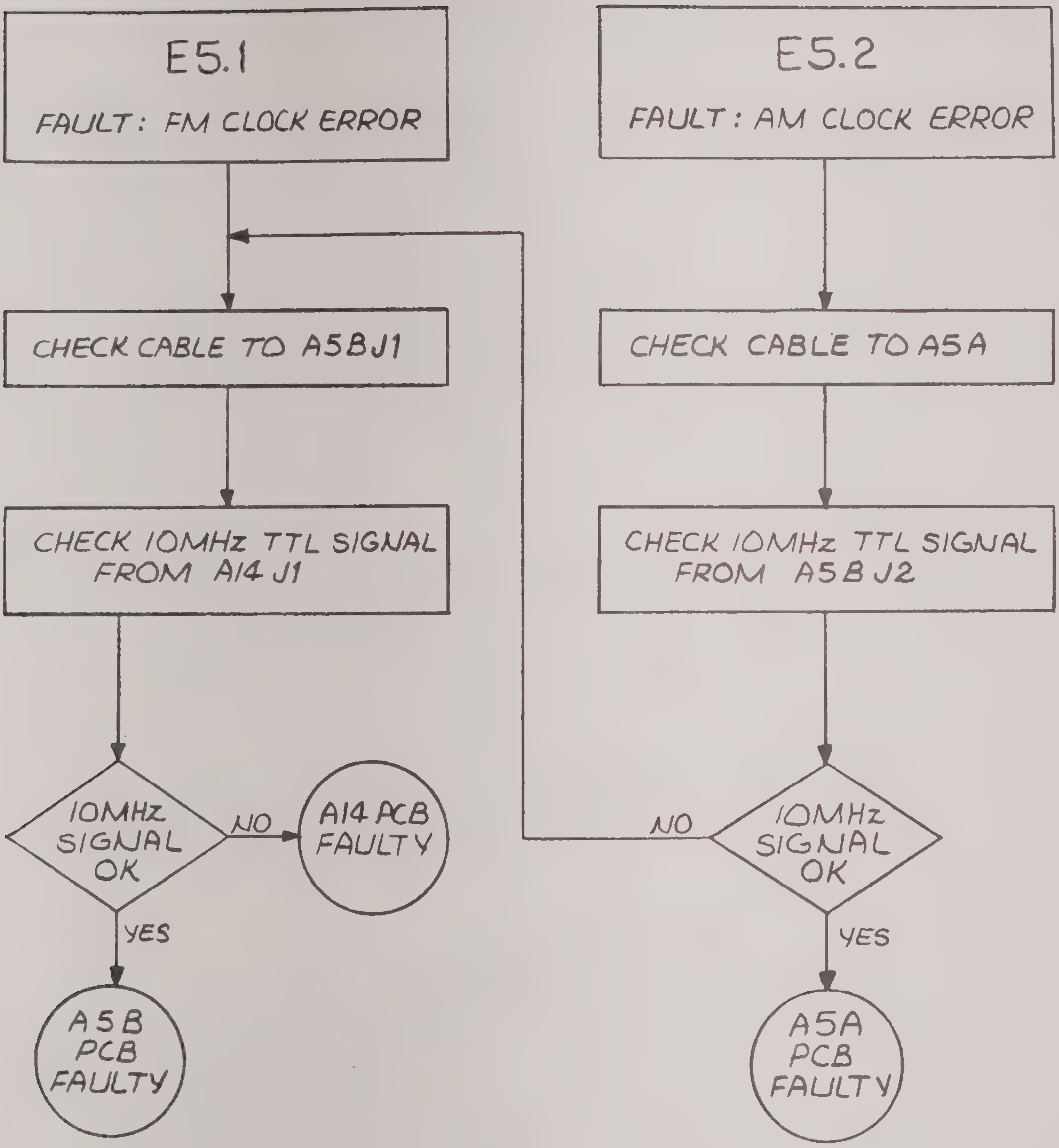

E5.1
FAULT: FM CLOCK ERROR
CHECK CABLE TO A5BJ1
CHECK 10MHz TTL SIGNAL FROM A14 J1
10MHz SIGNAL OK
NO
A14 PCB FAULTY
YES
A5B PCB FAULTY
E5.2
FAULT: AM CLOCK ERROR
CHECK CABLE TO A5A
CHECK 10MHz TTL SIGNAL FROM A5B J2
10MHz SIGNAL OK
NO
YES
A5A PCB FAULTY

Figure 3-4. Troubleshooting Flowchart — Error Codes 5.1 and 5.2

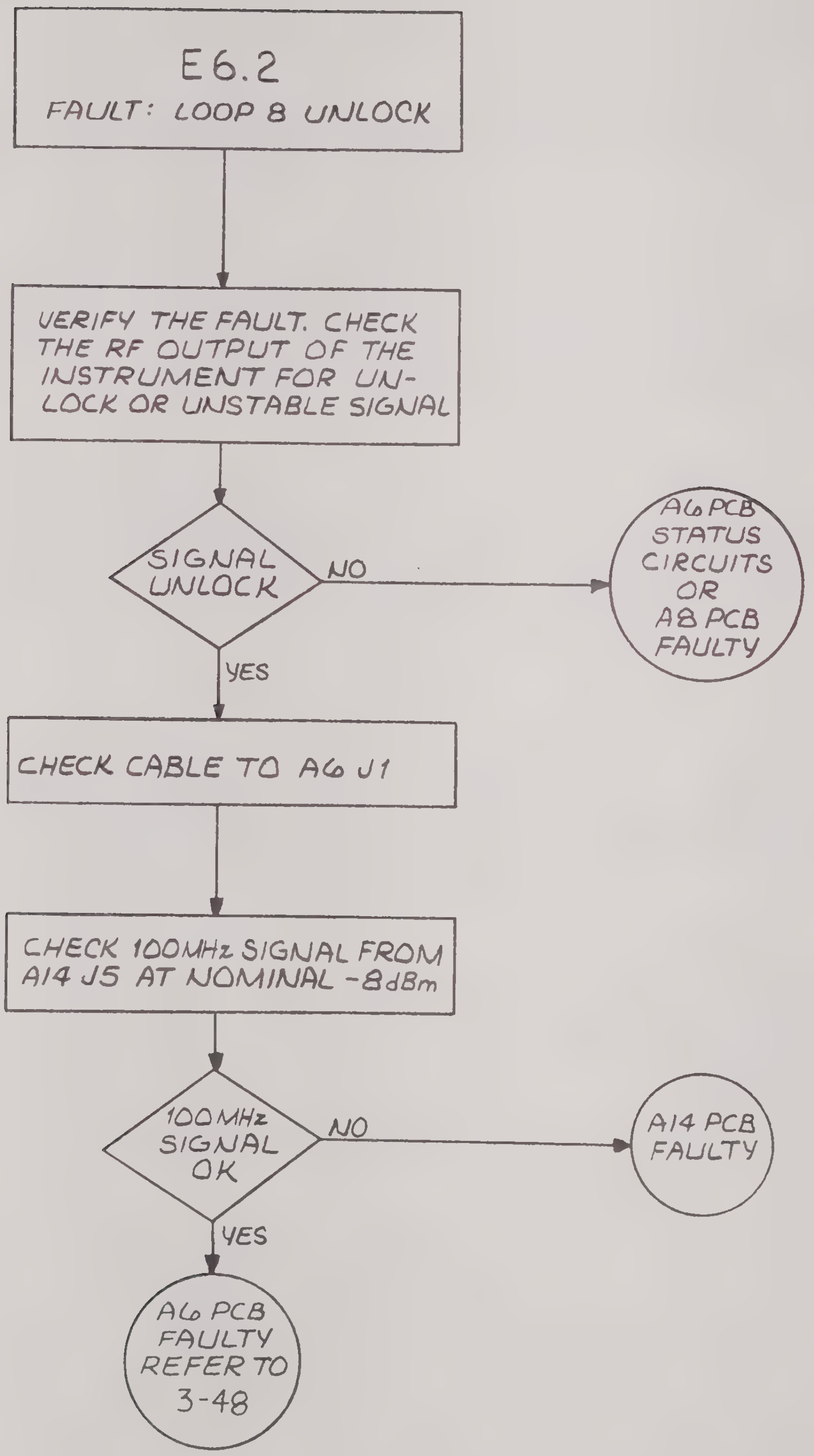

E6.2
FAULT: LOOP 8 UNLOCK
VERIFY THE FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A6 PCB STATUS CIRCUITS OR A8 PCB FAULTY
YES
CHECK CABLE TO A6 J1
CHECK 100MHz SIGNAL FROM A14 J5 AT NOMINAL -8dBm
100MHz SIGNAL OK
NO
A14 PCB FAULTY
YES
A6 PCB FAULTY REFER TO 3-48

Figure 3-5. Troubleshooting Flowchart — Error Code 6.2

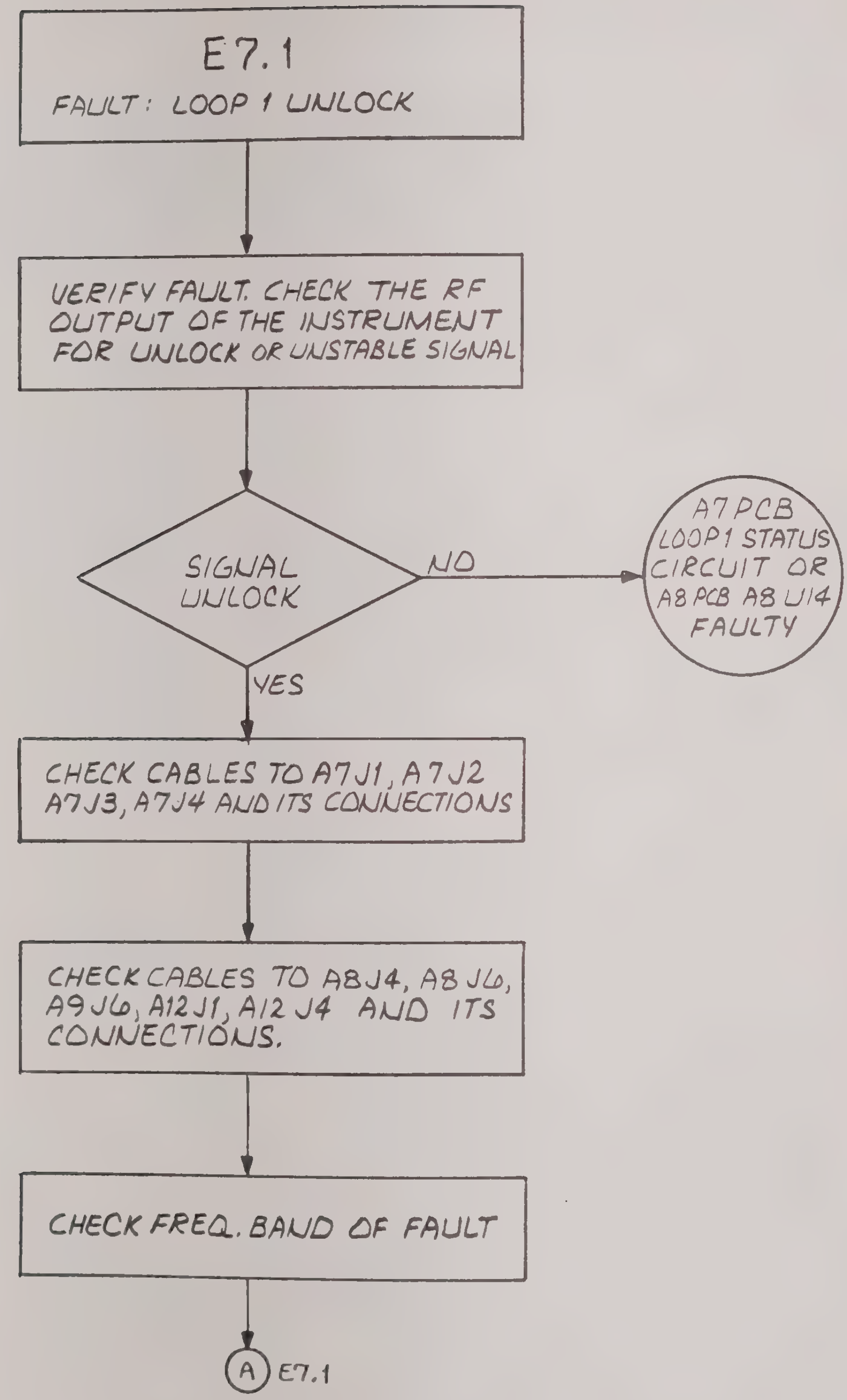

E7.1
FAULT: LOOP 1 UNLOCK
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A7 PCB LOOP1 STATUS CIRCUIT OR A8 PCB A8 U14 FAULTY
YES
CHECK CABLES TO A7J1, A7J2 A7J3, A7J4 AND ITS CONNECTIONS
CHECK CABLES TO A8J4, A8J6, A9J6, A12J1, A12J4 AND ITS CONNECTIONS.
CHECK FREQ. BAND OF FAULT
A
E7.1

Figure 3-6. Troubleshooting Flowchart — Error Code 7.1 (Sheet 1 of 4)

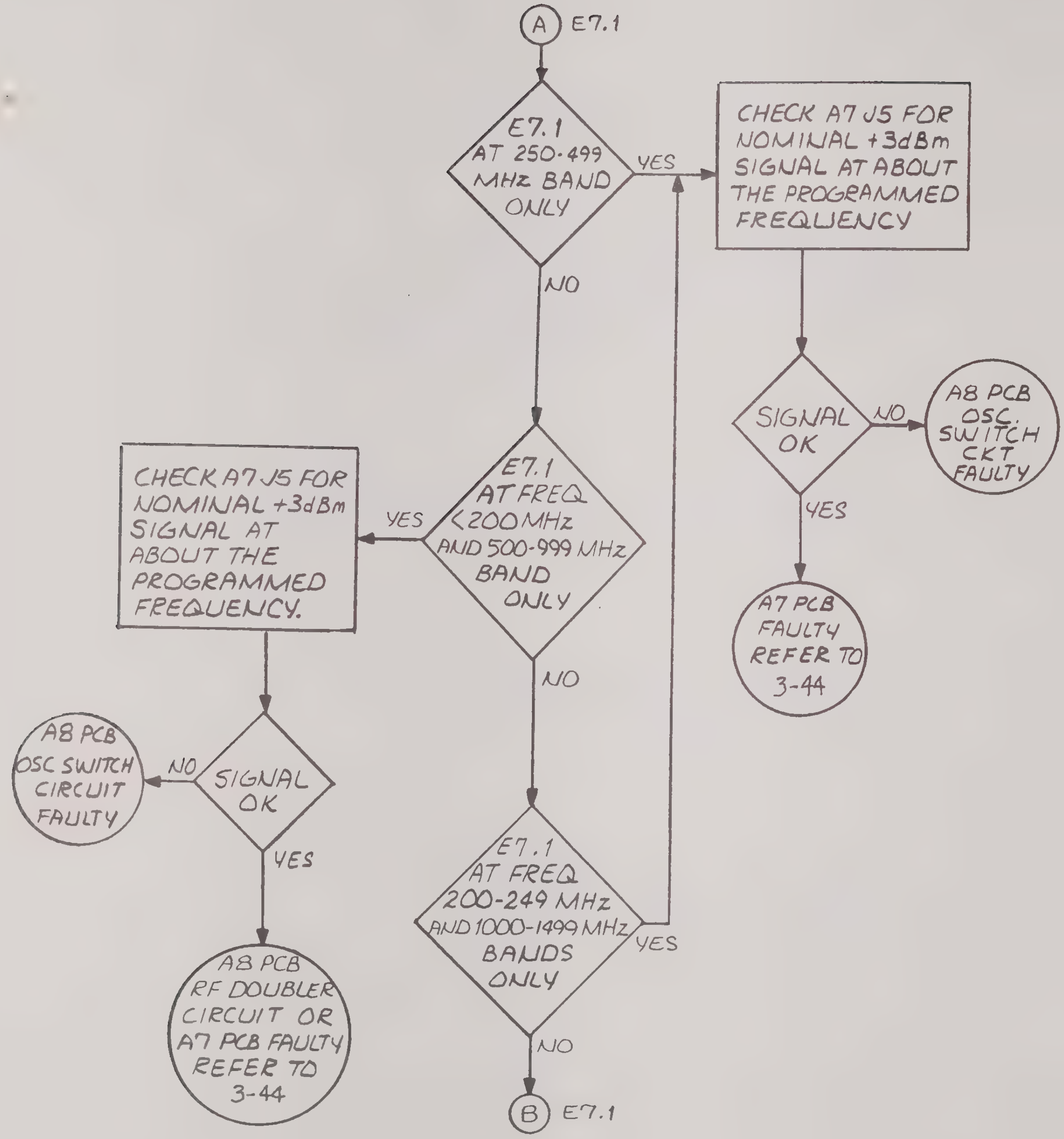

A E7.1
E7.1 AT 250-499 MHz BAND ONLY
YES
CHECK A7 J5 FOR NOMINAL +3dBm SIGNAL AT ABOUT THE PROGRAMMED FREQUENCY
NO
SIGNAL OK
NO
A8 PCB OSC. SWITCH CKT FAULTY
YES
A7 PCB FAULTY REFER TO 3-44
E7.1 AT FREQ <200 MHz AND 500-999 MHz BAND ONLY
YES
CHECK A7 J5 FOR NOMINAL +3dBm SIGNAL AT ABOUT THE PROGRAMMED FREQUENCY.
SIGNAL OK
NO
A8 PCB OSC SWITCH CIRCUIT FAULTY
YES
A8 PCB RF DOUBLER CIRCUIT OR A7 PCB FAULTY REFER TO 3-44
NO
E7.1 AT FREQ 200-249 MHz AND 1000-1499 MHz BANDS ONLY
YES
NO
B E7.1

Figure 3-6. Troubleshooting Flowchart — Error Code 7.1 (Sheet 2 of 4)

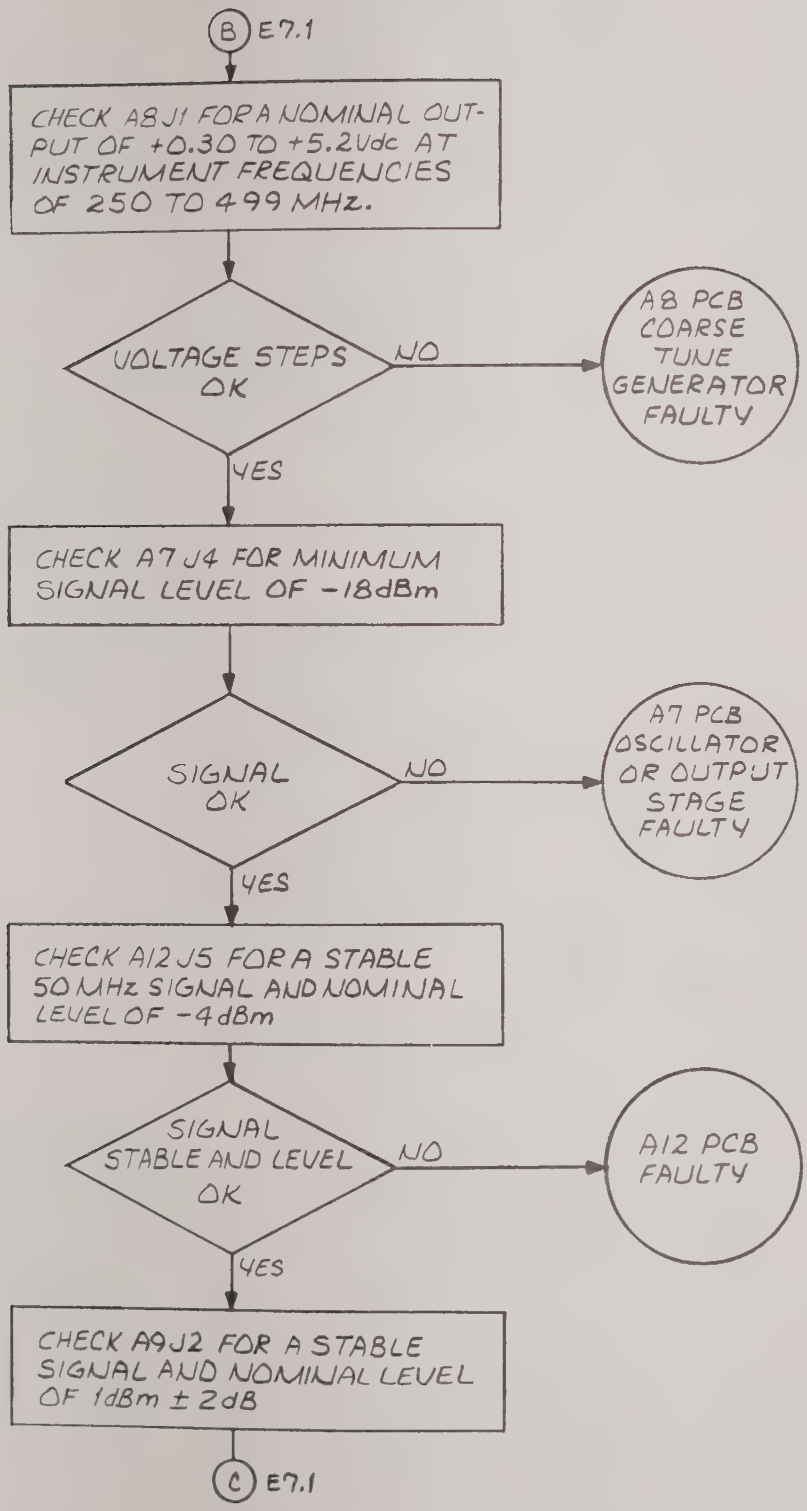
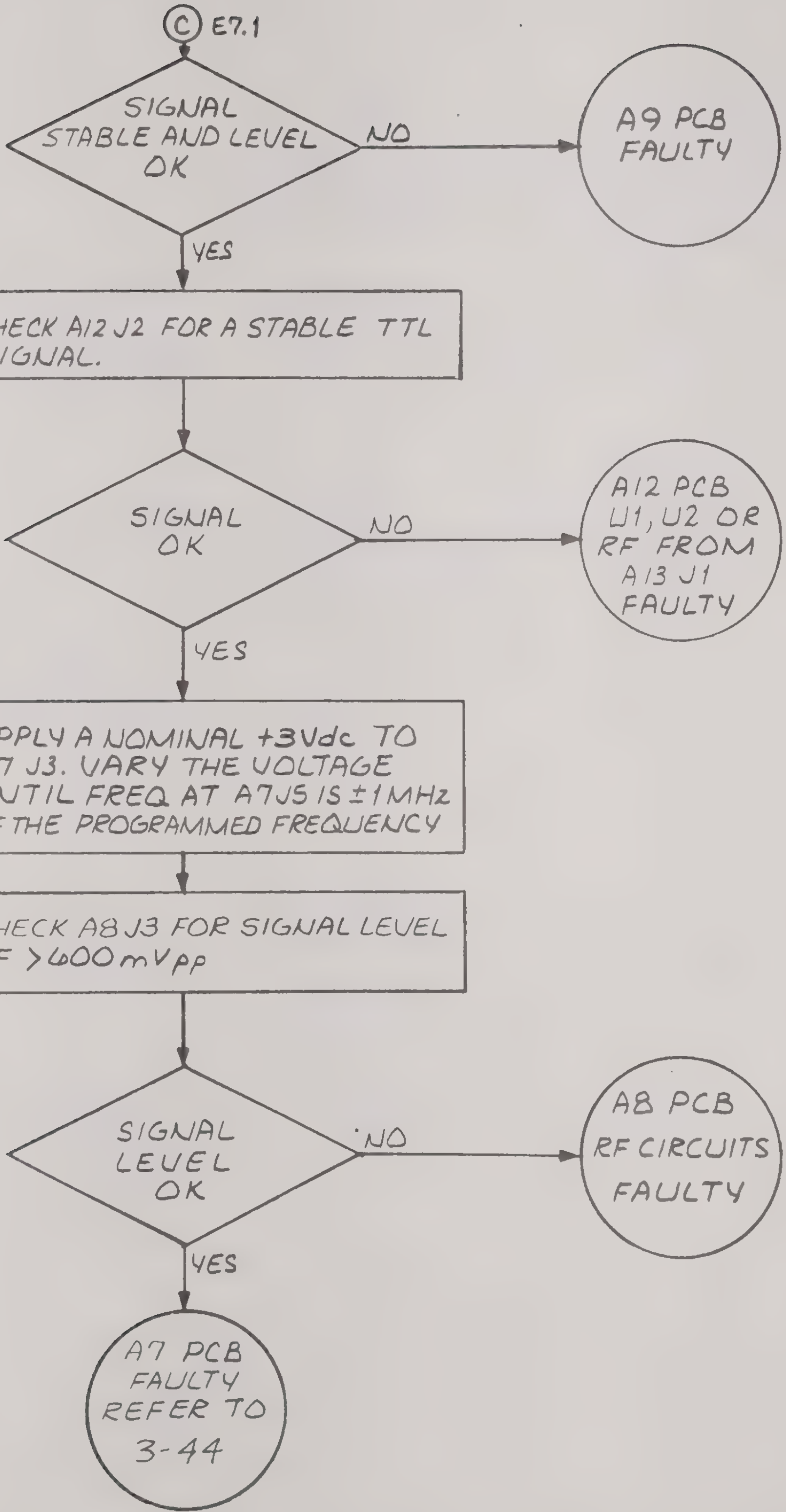

B
E7.1
CHECK A8J1 FOR A NOMINAL OUTPUT OF +0.30 TO +5.2Vdc AT INSTRUMENT FREQUENCIES OF 250 TO 499 MHz.
VOLTAGE STEPS OK
NO
A8 PCB COARSE TUNE GENERATOR FAULTY
YES
CHECK A7 J4 FOR MINIMUM SIGNAL LEVEL OF -18dBm
SIGNAL OK
NO
A7 PCB OSCILLATOR OR OUTPUT STAGE FAULTY
YES
CHECK A12 J5 FOR A STABLE 50 MHz SIGNAL AND NOMINAL LEVEL OF -4 dBm
SIGNAL STABLE AND LEVEL OK
NO
A12 PCB FAULTY
YES
CHECK A9J2 FOR A STABLE SIGNAL AND NOMINAL LEVEL OF 1dBm ± 2dB
C
E7.1

Figure 3-6. Troubleshooting Flowchart — Error Code 7.1 (Sheet 3 of 4)



C
E7.1
SIGNAL STABLE AND LEVEL OK
NO
A9 PCB FAULTY
YES
CHECK A12 J2 FOR A STABLE TTL SIGNAL.
SIGNAL OK
NO
A12 PCB U1, U2 OR RF FROM A13 J1 FAULTY
YES
APPLY A NOMINAL +3Vdc TO A7 J3. VARY THE VOLTAGE UNTIL FREQ AT A7J5 IS ±1MHz OF THE PROGRAMMED FREQUENCY
CHECK A8 J3 FOR SIGNAL LEVEL OF >600 mVpp
SIGNAL LEVEL OK
NO
A8 PCB RF CIRCUITS FAULTY
YES
A7 PCB FAULTY REFER TO 3-44

Figure 3-6. Troubleshooting Flowchart — Error Code 7.1 (Sheet 4 of 4)

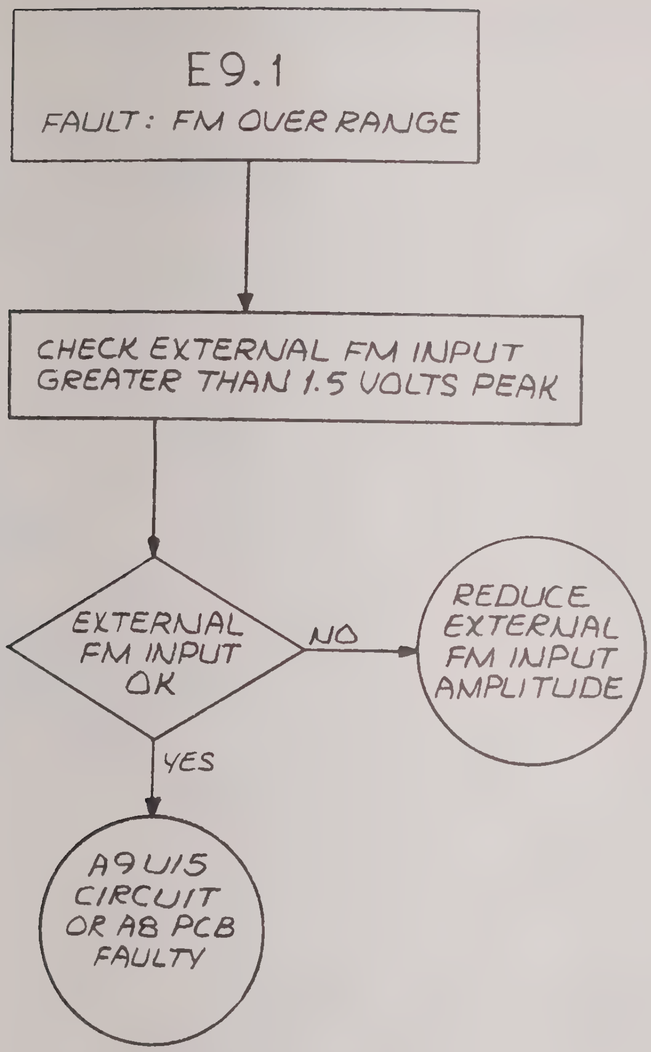

E9.1
FAULT: FM OVER RANGE
CHECK EXTERNAL FM INPUT GREATER THAN 1.5 VOLTS PEAK
EXTERNAL FM INPUT OK
NO
REDUCE EXTERNAL FM INPUT AMPLITUDE
YES
A9 U15 CIRCUIT OR A8 PCB FAULTY

Figure 3-7. Troubleshooting Flowchart — Error Code 9.1

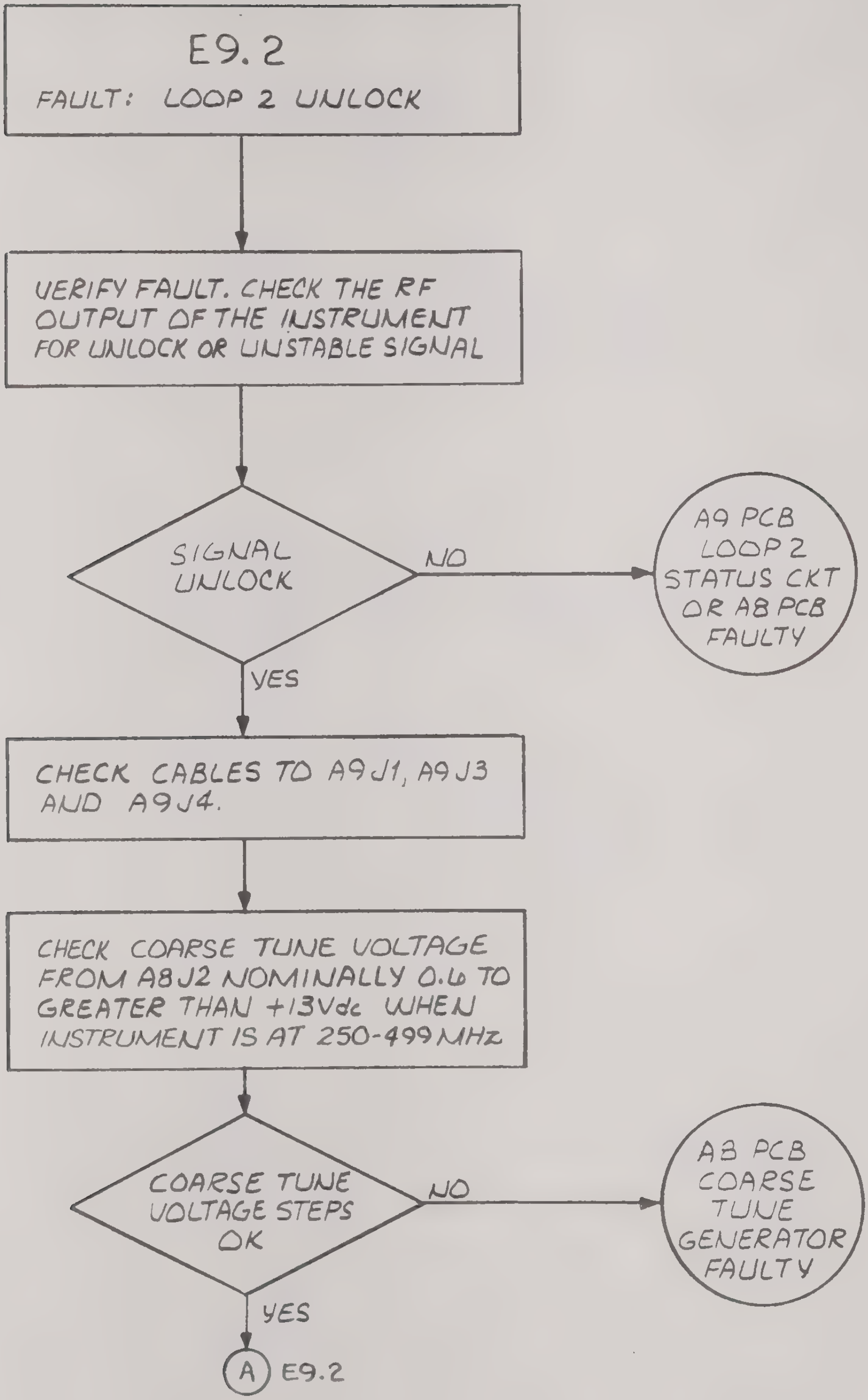

E9.2
FAULT: LOOP 2 UNLOCK
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A9 PCB LOOP 2 STATUS CKT OR A8 PCB FAULTY
YES
CHECK CABLES TO A9J1, A9J3 AND A9J4.
CHECK COARSE TUNE VOLTAGE FROM A8J2 NOMINALLY 0.6 TO GREATER THAN +13Vdc WHEN INSTRUMENT IS AT 250-499 MHz
COARSE TUNE VOLTAGE STEPS OK
NO
A8 PCB COARSE TUNE GENERATOR FAULTY
YES
A
E9.2

Figure 3-8. Troubleshooting Flowchart — Error Code 9.2 (Sheet 1 of 2)

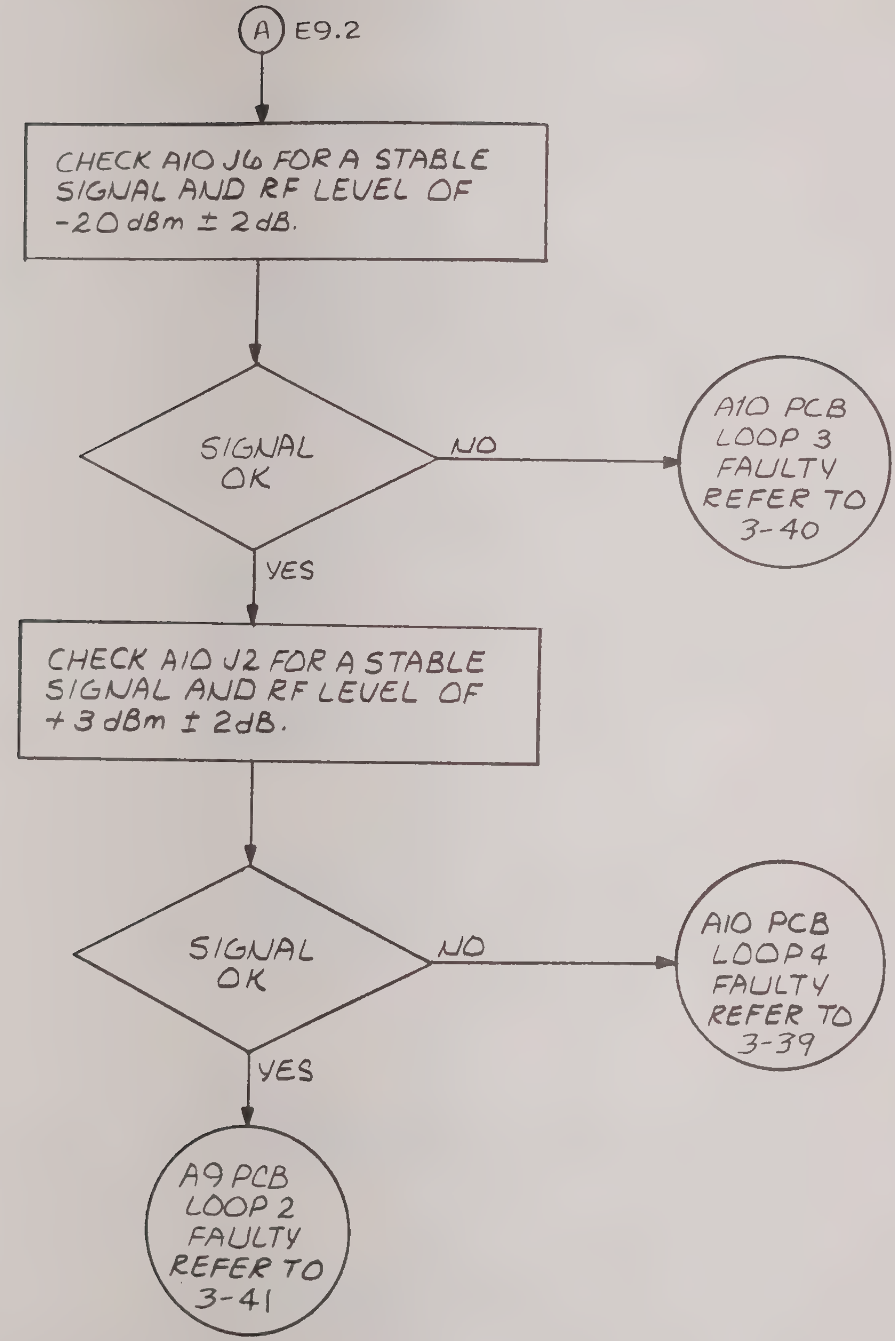

A
E9.2
CHECK A10 J6 FOR A STABLE SIGNAL AND RF LEVEL OF -20 dBm ± 2 dB.
SIGNAL OK
NO
A10 PCB LOOP 3 FAULTY REFER TO 3-40
YES
CHECK A10 J2 FOR A STABLE SIGNAL AND RF LEVEL OF +3 dBm ± 2 dB.
SIGNAL OK
NO
A10 PCB LOOP 4 FAULTY REFER TO 3-39
YES
A9 PCB LOOP 2 FAULTY REFER TO 3-41

Figure 3-8. Troubleshooting Flowchart — Error Code 9.2 (Sheet 2 of 2)

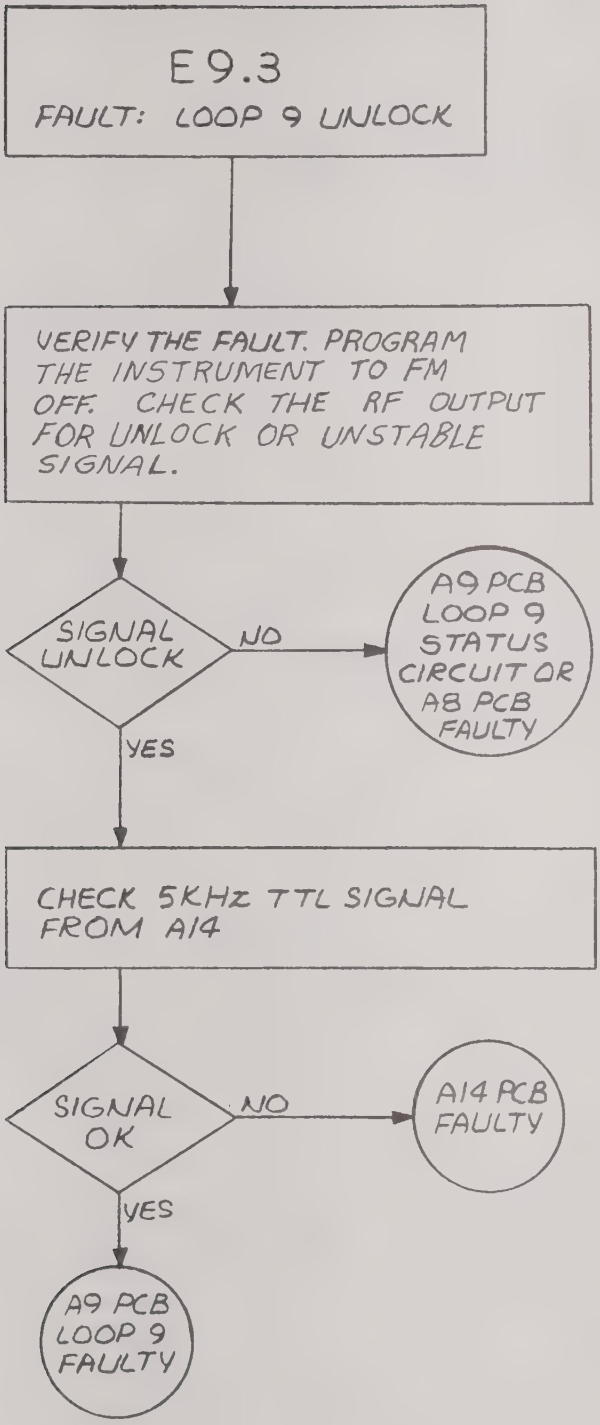

E9.3
FAULT: LOOP 9 UNLOCK
VERIFY THE FAULT. PROGRAM THE INSTRUMENT TO FM OFF. CHECK THE RF OUTPUT FOR UNLOCK OR UNSTABLE SIGNAL.
SIGNAL UNLOCK
NO
A9 PCB LOOP 9 STATUS CIRCUIT OR A8 PCB FAULTY
YES
CHECK 5KHz TTL SIGNAL FROM A14
SIGNAL OK
NO
A14 PCB FAULTY
YES
A9 PCB LOOP 9 FAULTY

Figure 3-9. Troubleshooting Flowchart – Error Code 9.3

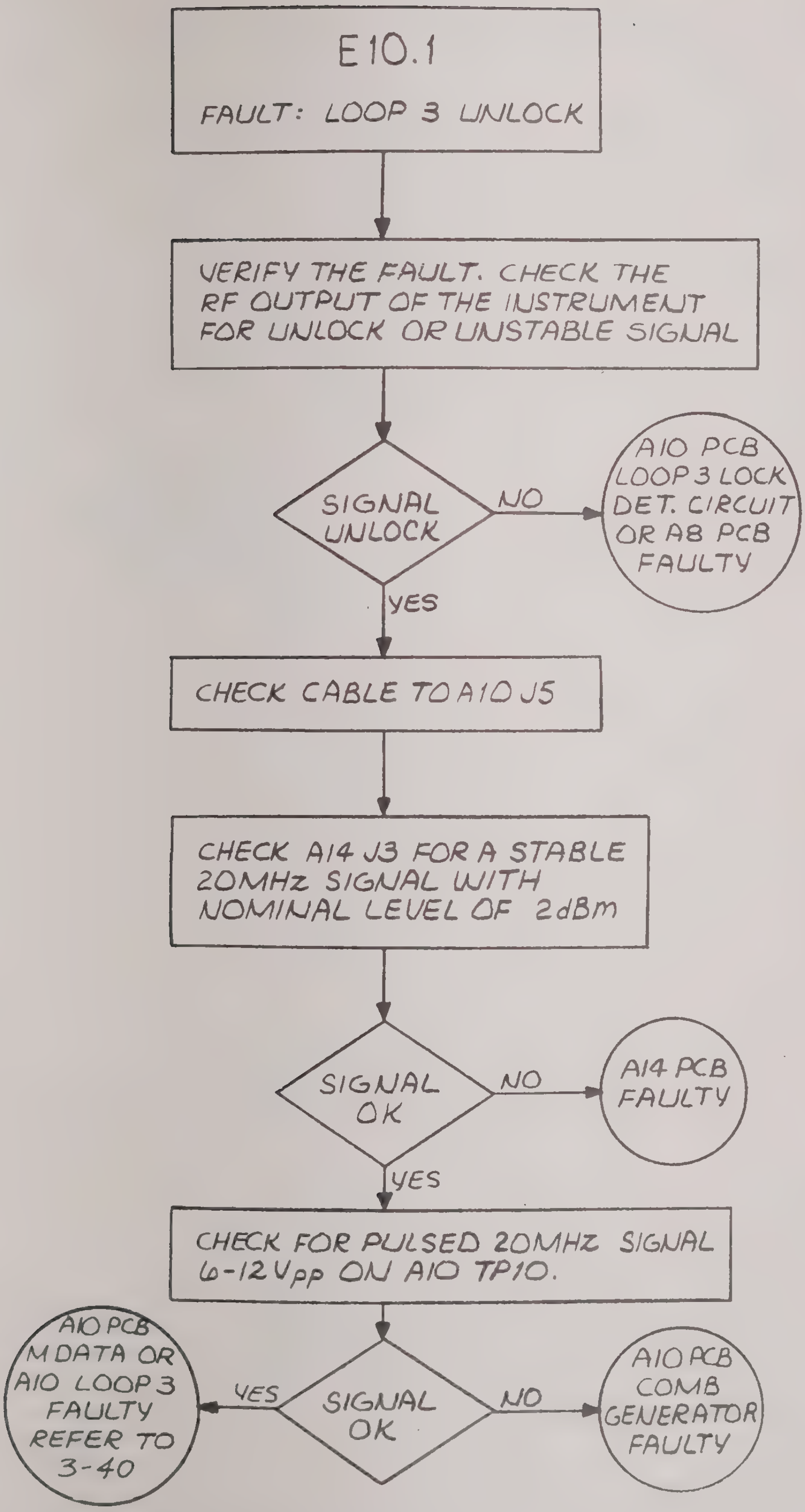

E10.1
FAULT: LOOP 3 UNLOCK
VERIFY THE FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A10 PCB LOOP 3 LOCK DET. CIRCUIT OR A8 PCB FAULTY
YES
CHECK CABLE TO A10 J5
CHECK A14 J3 FOR A STABLE 20MHz SIGNAL WITH NOMINAL LEVEL OF 2dBm
SIGNAL OK
NO
A14 PCB FAULTY
YES
CHECK FOR PULSED 20MHZ SIGNAL 6-12 Vpp ON A10 TP10.
SIGNAL OK
YES
A10 PCB M DATA OR A10 LOOP 3 FAULTY REFER TO 3-40
NO
A10 PCB COMB GENERATOR FAULTY

Figure 3-10. Troubleshooting Flowchart — Error Code 10.1

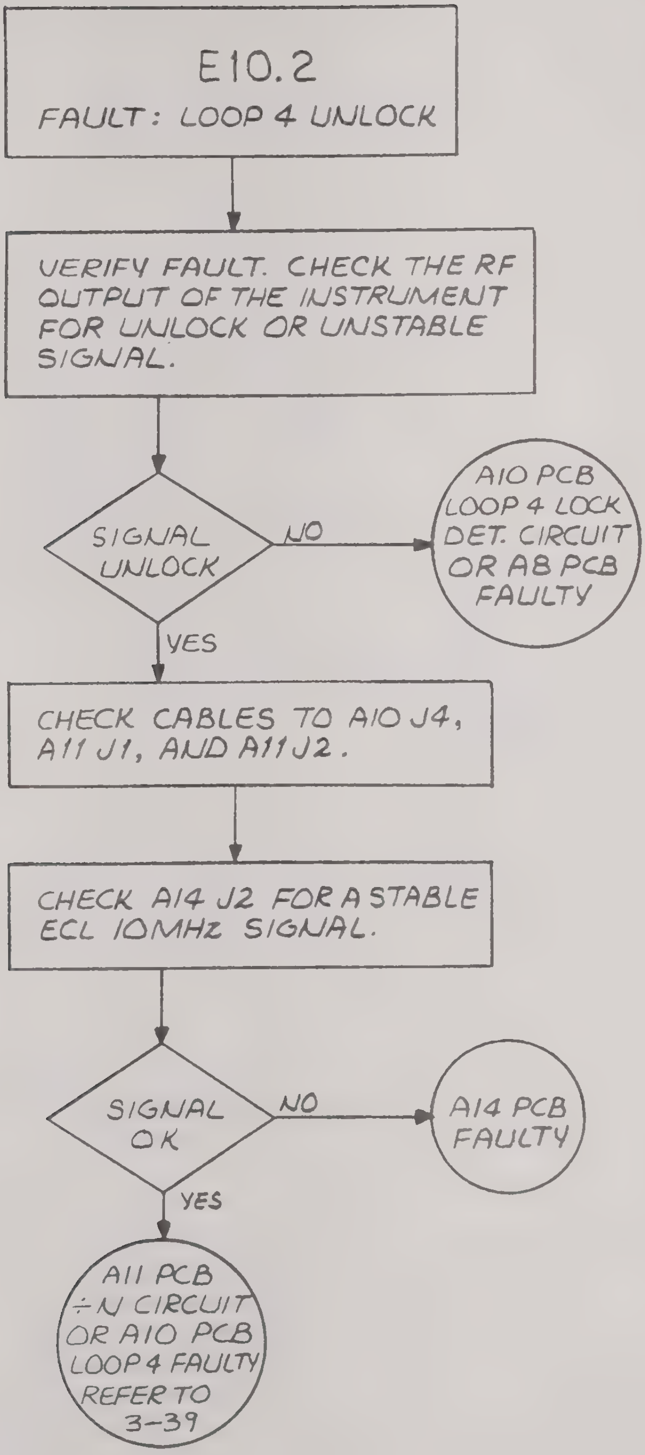

E10.2
FAULT: LOOP 4 UNLOCK
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL.
SIGNAL UNLOCK
NO
A10 PCB LOOP 4 LOCK DET. CIRCUIT OR A8 PCB FAULTY
YES
CHECK CABLES TO A10 J4, A11 J1, AND A11 J2.
CHECK A14 J2 FOR A STABLE ECL 10MHz SIGNAL.
SIGNAL OK
NO
A14 PCB FAULTY
YES
A11 PCB ÷N CIRCUIT OR A10 PCB LOOP 4 FAULTY REFER TO 3-39

Figure 3-11. Troubleshooting Flowchart — Error Code 10.2

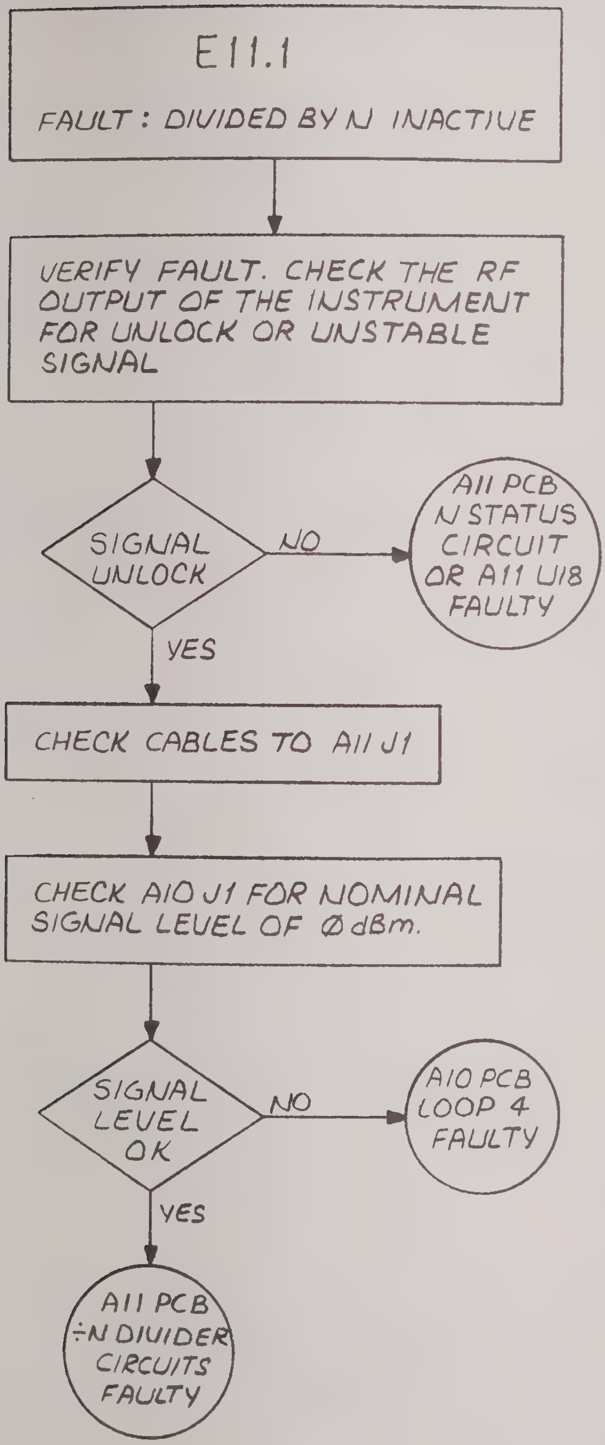

E11.1
FAULT: DIVIDED BY N INACTIVE
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A11 PCB N STATUS CIRCUIT OR A11 U18 FAULTY
YES
CHECK CABLES TO A11 J1
CHECK A10 J1 FOR NOMINAL SIGNAL LEVEL OF 0 dBm.
SIGNAL LEVEL OK
NO
A10 PCB LOOP 4 FAULTY
YES
A11 PCB ÷N DIVIDER CIRCUITS FAULTY

Figure 3-12. Troubleshooting Flowchart — Error Code 11.1

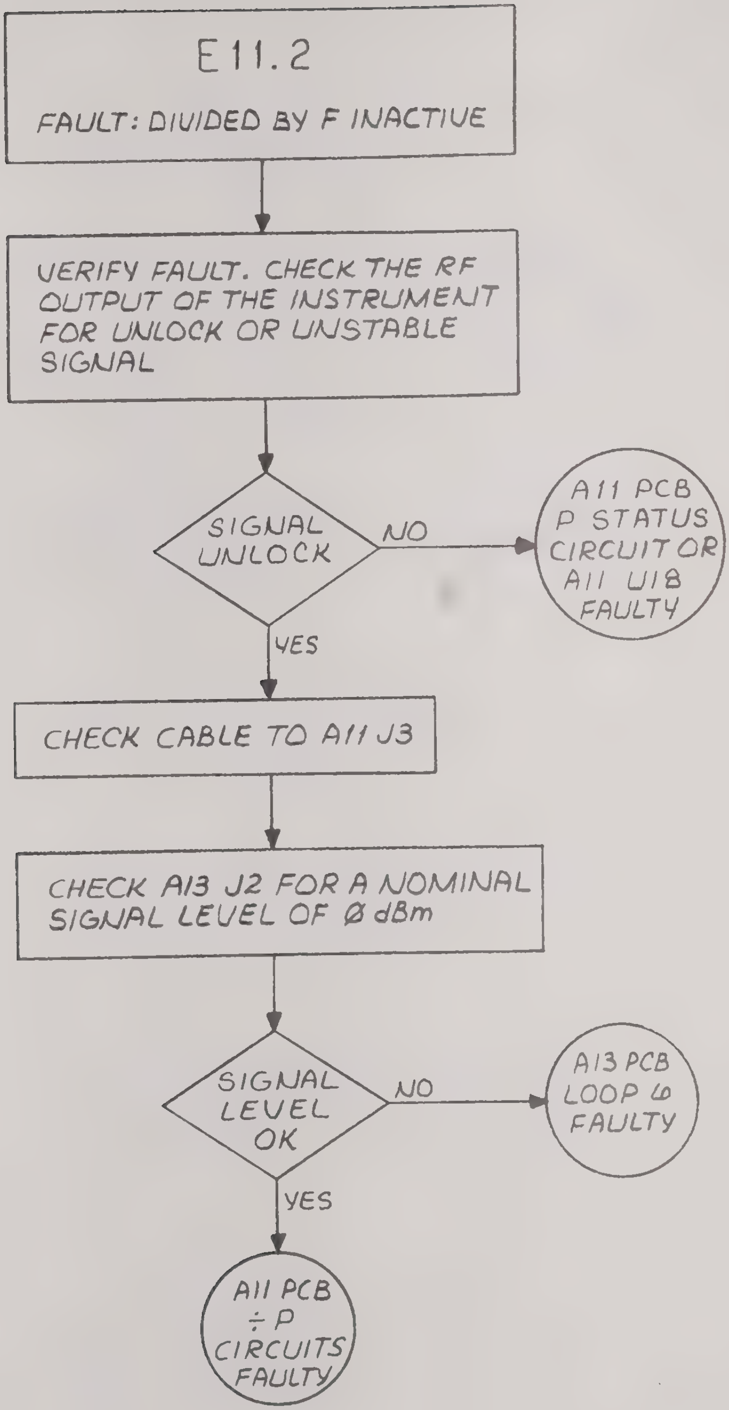

E11.2
FAULT: DIVIDED BY F INACTIVE
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A11 PCB P STATUS CIRCUIT OR A11 U18 FAULTY
YES
CHECK CABLE TO A11 J3
CHECK A13 J2 FOR A NOMINAL SIGNAL LEVEL OF 0 dBm
SIGNAL LEVEL OK
NO
A13 PCB LOOP 6 FAULTY
YES
A11 PCB ÷P CIRCUITS FAULTY

Figure 3-13. Troubleshooting Flowchart — Error Code 11.2

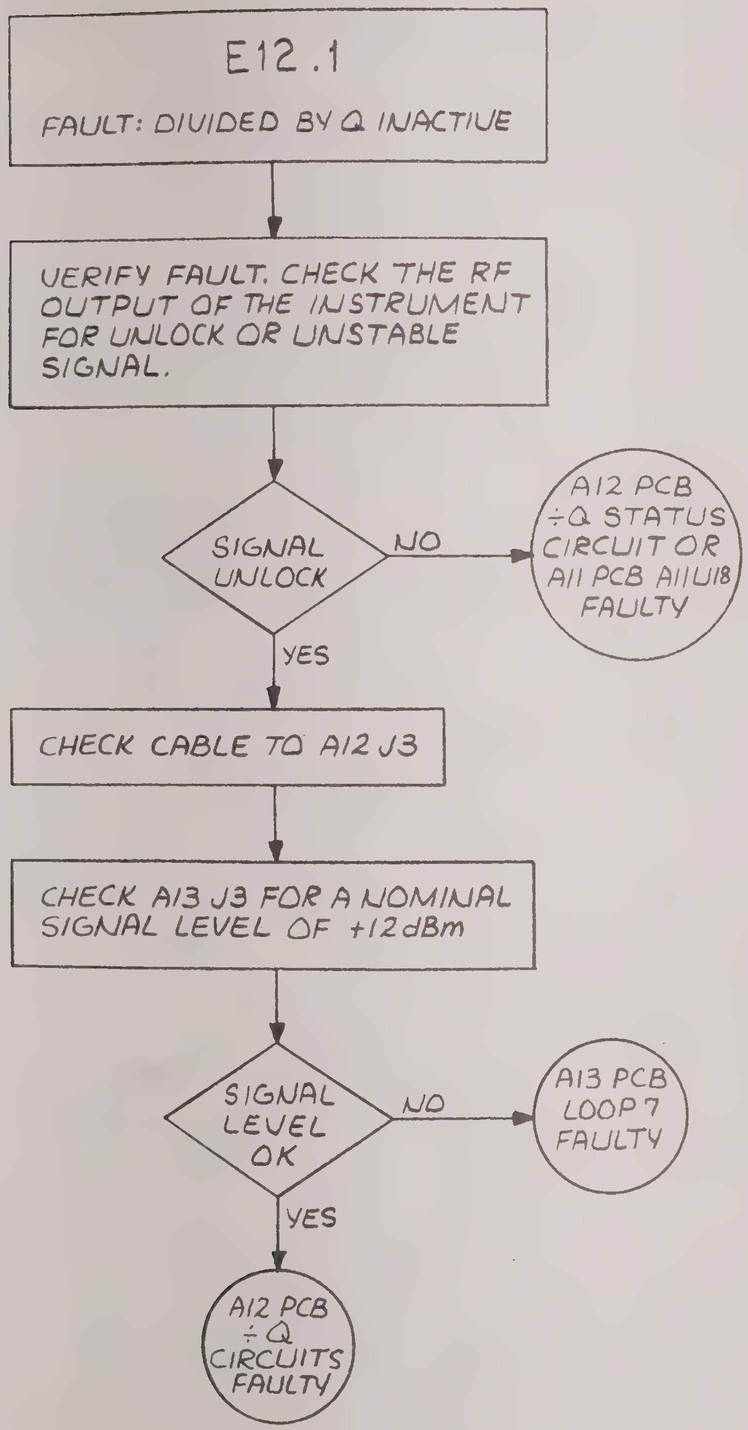

E12.1
FAULT: DIVIDED BY Q INACTIVE
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL.
SIGNAL UNLOCK
NO
A12 PCB ÷Q STATUS CIRCUIT OR A11 PCB A11U18 FAULTY
YES
CHECK CABLE TO A12 J3
CHECK A13 J3 FOR A NOMINAL SIGNAL LEVEL OF +12dBm
SIGNAL LEVEL OK
NO
A13 PCB LOOP 7 FAULTY
YES
A12 PCB ÷Q CIRCUITS FAULTY

Figure 3-14. Troubleshooting Flowchart — Error Code 12.1

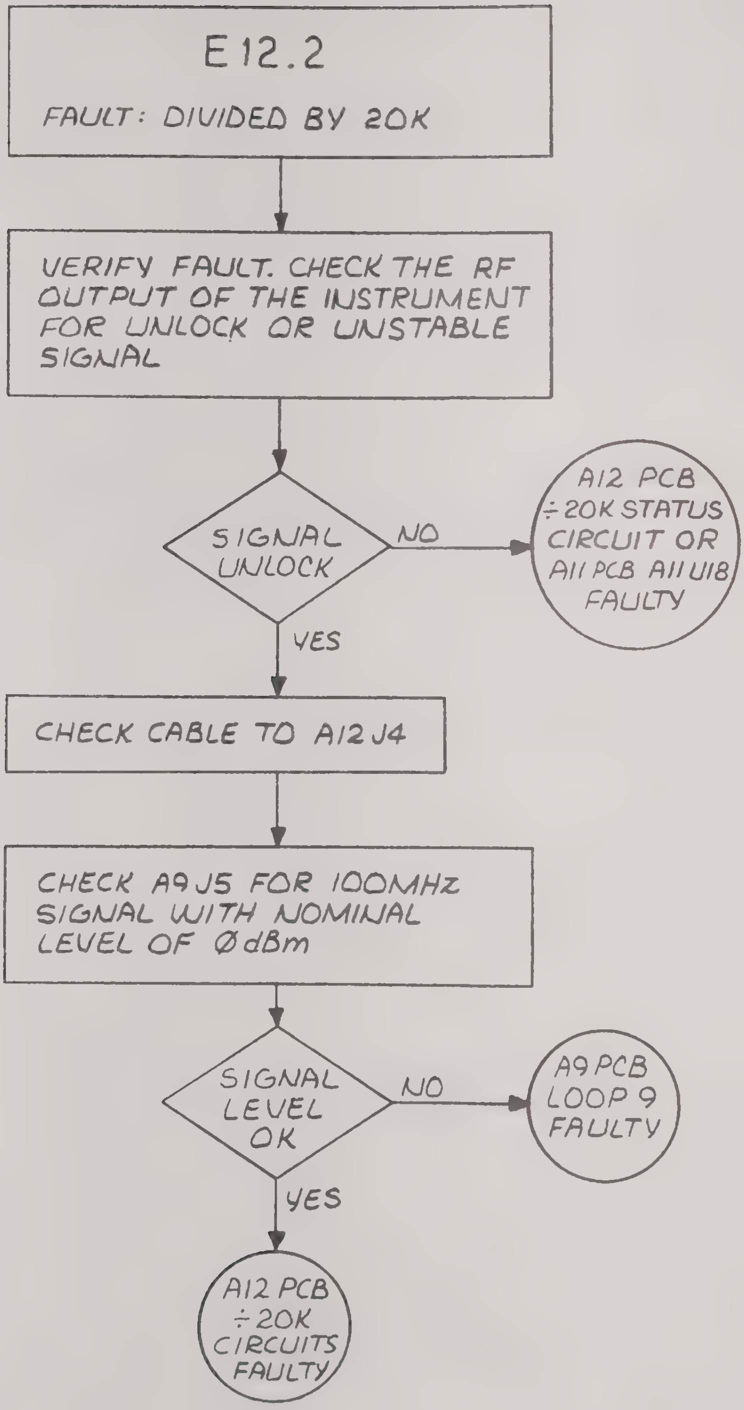

E12.2
FAULT: DIVIDED BY 20K
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A12 PCB ÷20K STATUS CIRCUIT OR A11 PCB A11 U18 FAULTY
YES
CHECK CABLE TO A12 J4
CHECK A9 J5 FOR 100MHz SIGNAL WITH NOMINAL LEVEL OF 0 dBm
SIGNAL LEVEL OK
NO
A9 PCB LOOP 9 FAULTY
YES
A12 PCB ÷20K CIRCUITS FAULTY

Figure 3-15. Troubleshooting Flowchart – Error Code 12.2

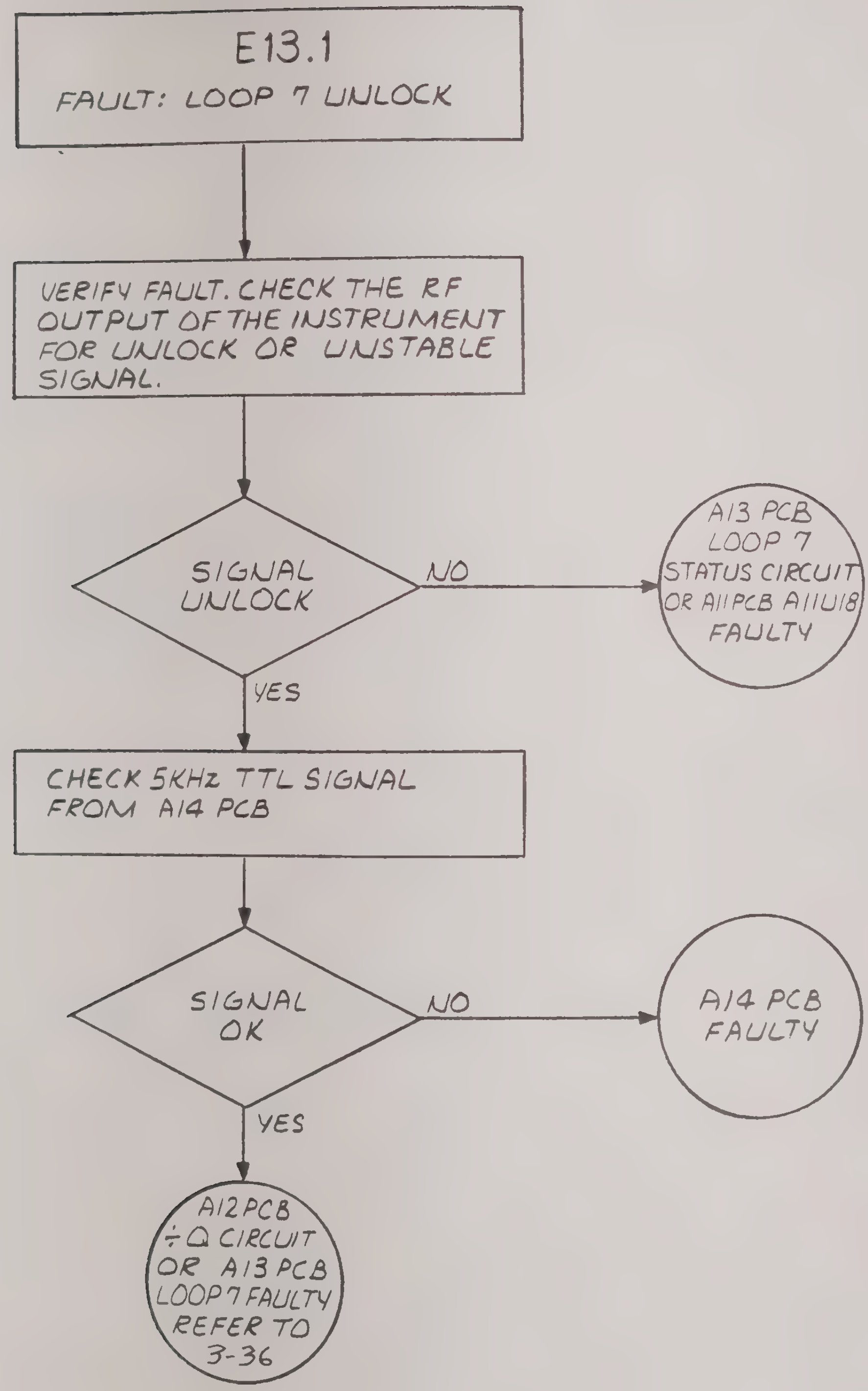

E13.1
FAULT: LOOP 7 UNLOCK
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL.
SIGNAL UNLOCK
NO
A13 PCB LOOP 7 STATUS CIRCUIT OR A11 PCB A11U18 FAULTY
YES
CHECK 5KHz TTL SIGNAL FROM A14 PCB
SIGNAL OK
NO
A14 PCB FAULTY
YES
A12 PCB ÷Q CIRCUIT OR A13 PCB LOOP 7 FAULTY REFER TO 3-36

Figure 3-16. Troubleshooting Flowchart — Error Code 13.1

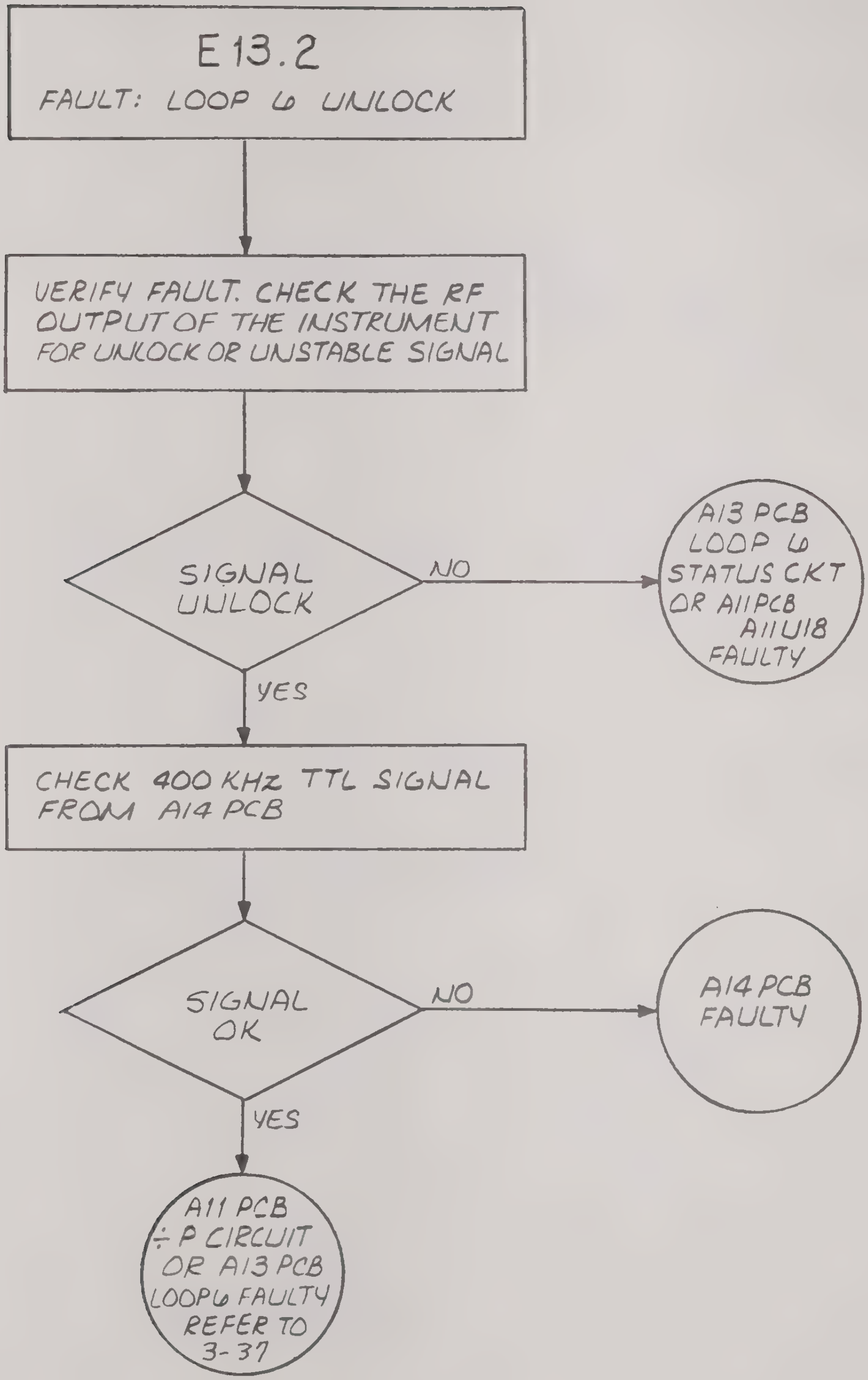

E13.2
FAULT: LOOP 6 UNLOCK
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A13 PCB LOOP 6 STATUS CKT OR A11 PCB A11U18 FAULTY
YES
CHECK 400 KHz TTL SIGNAL FROM A14 PCB
SIGNAL OK
NO
A14 PCB FAULTY
YES
A11 PCB ÷ P CIRCUIT OR A13 PCB LOOP6 FAULTY REFER TO 3-37

Figure 3-17. Troubleshooting Flowchart — Error Code 13.2

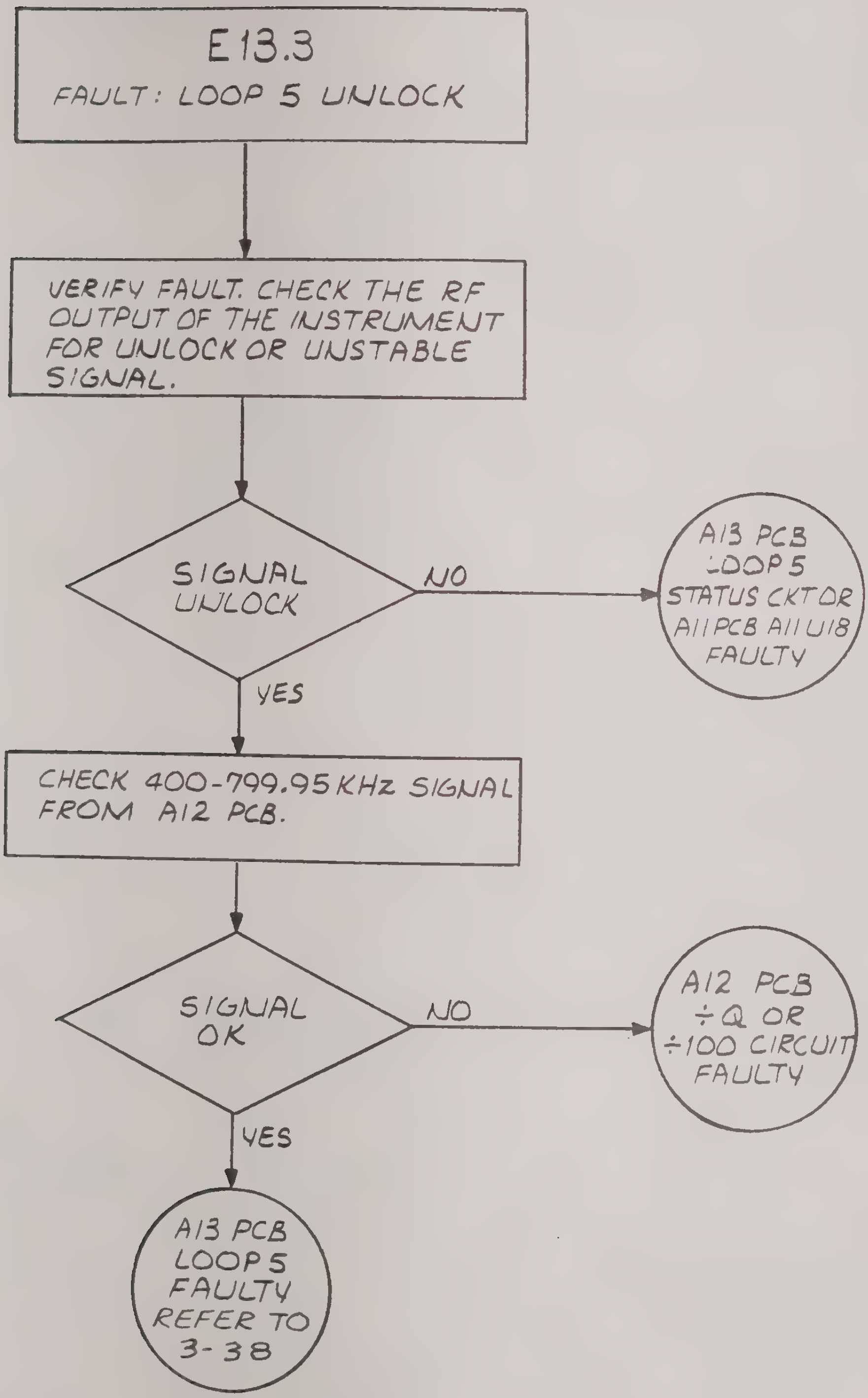

E13.3
FAULT: LOOP 5 UNLOCK
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL.
SIGNAL UNLOCK
NO
A13 PCB LOOP 5 STATUS CKT OR A11 PCB A11 U18 FAULTY
YES
CHECK 400-799.95 KHz SIGNAL FROM A12 PCB.
SIGNAL OK
NO
A12 PCB ÷Q OR ÷100 CIRCUIT FAULTY
YES
A13 PCB LOOP 5 FAULTY REFER TO 3-38

Figure 3-18. Troubleshooting Flowchart — Error Code 13.3

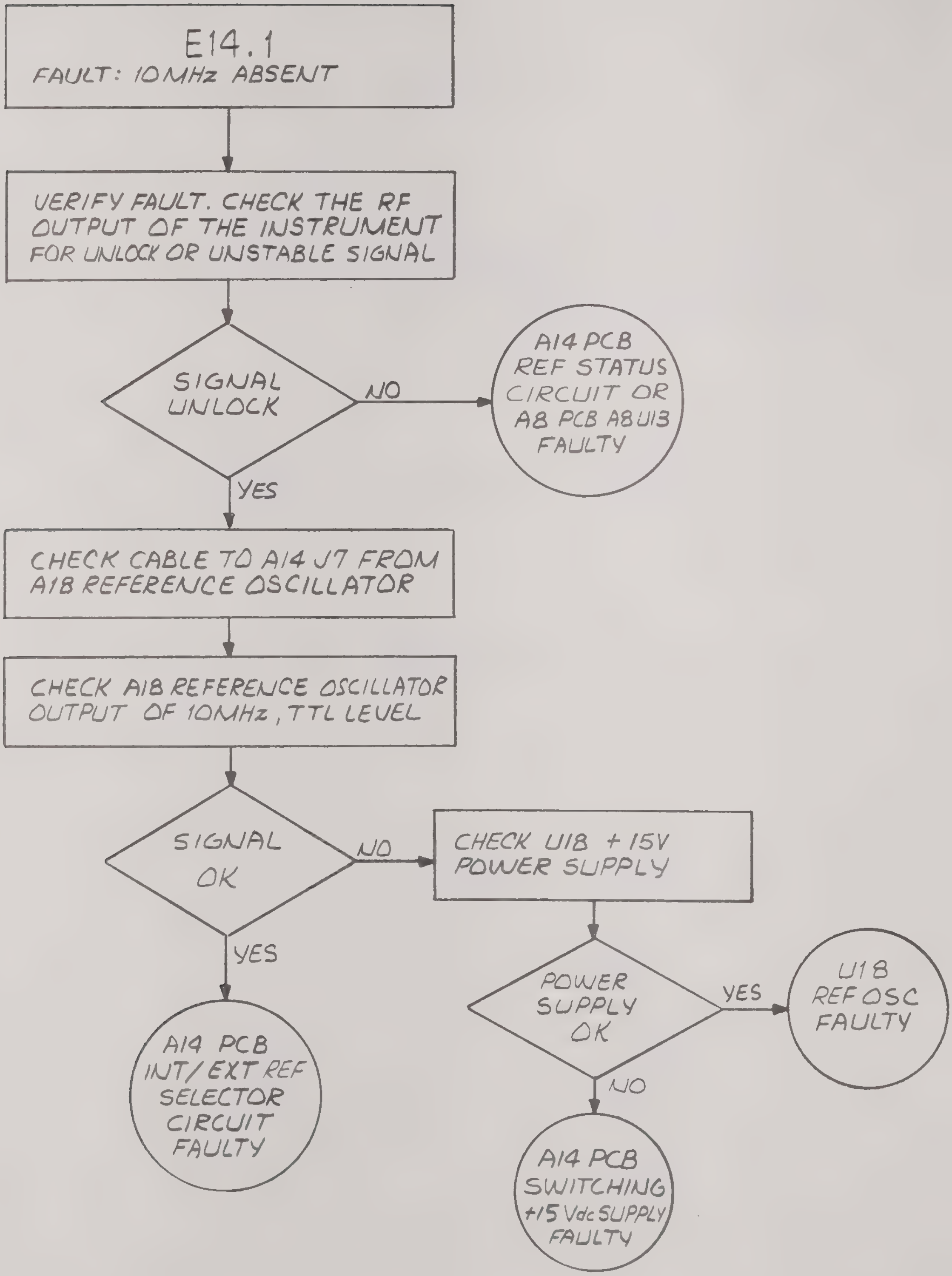

E14.1
FAULT: 10MHz ABSENT
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL
SIGNAL UNLOCK
NO
A14 PCB REF STATUS CIRCUIT OR A8 PCB A8U13 FAULTY
YES
CHECK CABLE TO A14 J7 FROM A18 REFERENCE OSCILLATOR
CHECK A18 REFERENCE OSCILLATOR OUTPUT OF 10MHz, TTL LEVEL
SIGNAL OK
NO
CHECK U18 +15V POWER SUPPLY
YES
A14 PCB INT/EXT REF SELECTOR CIRCUIT FAULTY
POWER SUPPLY OK
YES
U18 REF OSC FAULTY
NO
A14 PCB SWITCHING +15 Vdc SUPPLY FAULTY

Figure 3-19. Troubleshooting Flowchart — Error Code 14.1

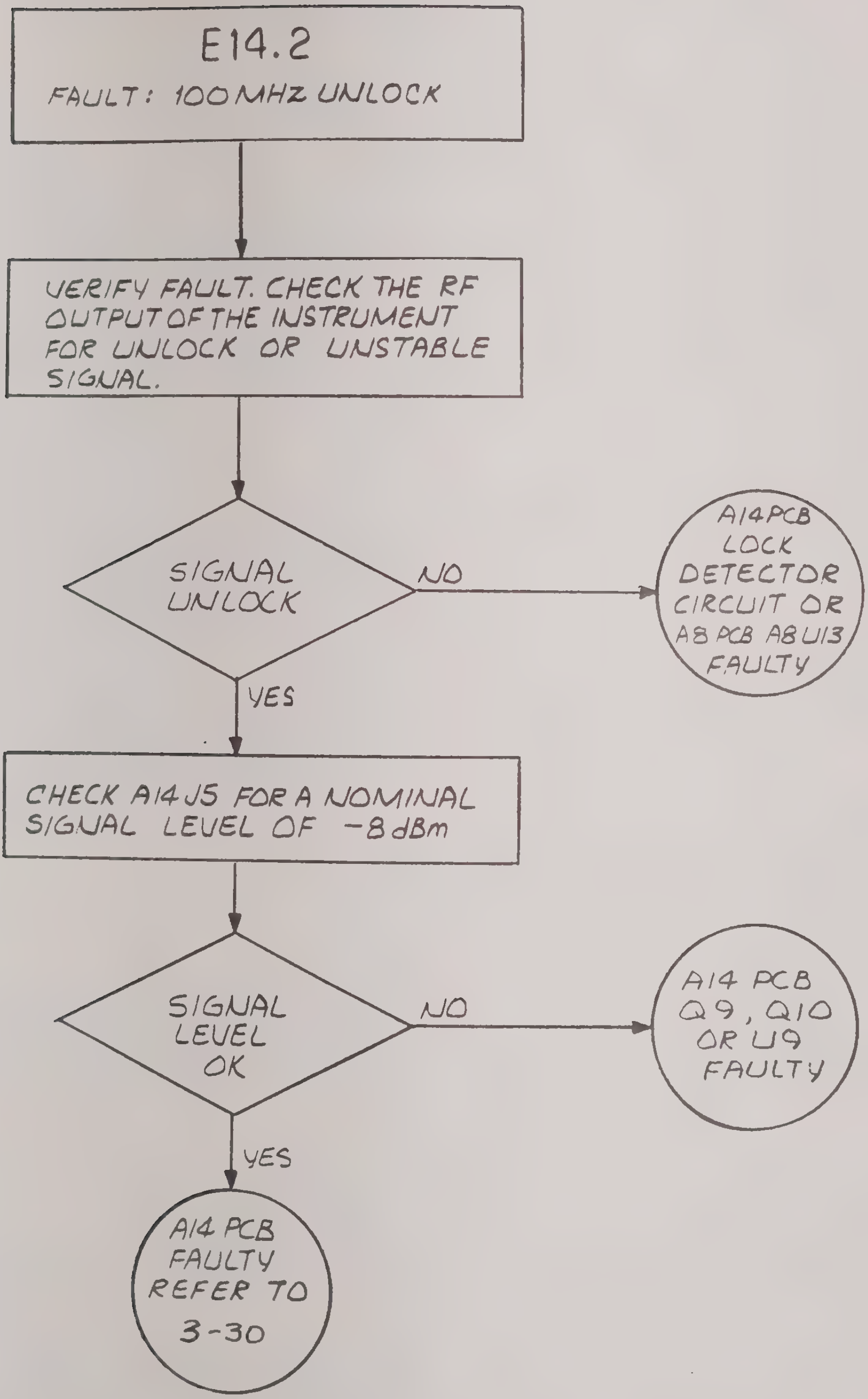

E14.2
FAULT: 100 MHZ UNLOCK
VERIFY FAULT. CHECK THE RF OUTPUT OF THE INSTRUMENT FOR UNLOCK OR UNSTABLE SIGNAL.
SIGNAL UNLOCK
NO
A14 PCB LOCK DETECTOR CIRCUIT OR A8 PCB A8 U13 FAULTY
YES
CHECK A14 J5 FOR A NOMINAL SIGNAL LEVEL OF −8 dBm
SIGNAL LEVEL OK
NO
A14 PCB Q9, Q10 OR U9 FAULTY
YES
A14 PCB FAULTY REFER TO 3-30

Figure 3-20. Troubleshooting Flowchart — Error Code 14.2

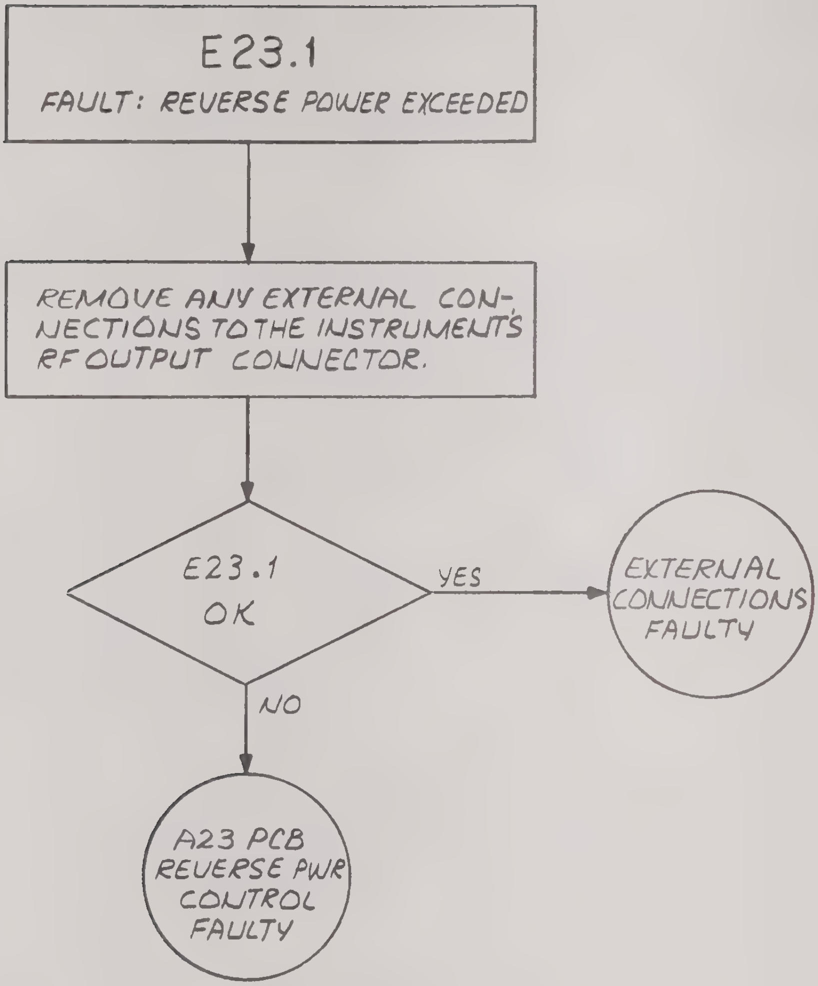

E23.1
FAULT: REVERSE POWER EXCEEDED
REMOVE ANY EXTERNAL CONNECTIONS TO THE INSTRUMENT'S RF OUTPUT CONNECTOR.
E23.1 OK
YES
EXTERNAL CONNECTIONS FAULTY
NO
A23 PCB REVERSE PWR CONTROL FAULTY

Figure 3-21. Troubleshooting Flowchart — Error Code 23.1

CHAPTER 4

REPLACEABLE PARTS

4-1. INTRODUCTION

4-1.1 This chapter contains the parts lists for each assembly in a 1500 Series Synthesized Signal Generator. Chapter 5 shows the assemblies where the listed parts are installed. Order information is included and should be used when purchasing parts from the factory. Explanation of the column listings and Table 4-1 Manufacturers' Code-To-Name Index are also included.

4-2. PART ORDERING INFORMATION

4-2.1 To order a part from the Replaceable Parts List, state the Systron Donner part number, indicate the quantity required, and address the order to the nearest Systron Donner Sales or Service Center.

4-2.2 To order a part not listed in the Replaceable Parts List, state the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Systron Donner Sales or Service Center.

4-3. PARTS LISTS

4-3.1 The replaceable parts lists are placed in A numbered sequence. Each column in the parts lists provide specific information relating to the listed parts as follows:

(1) ITEM NUMBER: This is the find number column and lists those find numbers as called out on the respective assembly drawing.

(2) SD PART NUMBER: The Systron Donner part number is listed in this column.

(3) COMPONENT DESCRIPTION: Component names and specifications are provided in these columns and include value, tolerance, wattage rating, working voltage, construction, etc.

(4) REFERENCE DESIGNATOR: Reference designators applicable to assemblies and components are listed in this column.

(5) TOTAL QTY (Total Quantity): This quantity, appearing after an item entry, indicates the number of times the component is used in that assembly. The total quantity for each part is given only once; at the first appearance of the part number in the list.

(6) CAGE (FSCM): H4/H8 Commercial and Government Entity (CAGE) [formerly identified as Federal Supply Code for Manufacturers (FSCM)] codes are listed to identify component manufacturers. A Manufacturers Index (table 4-1) is provided in this chapter for cross reference.

(7) MANUFACTURER'S PART NUMBER: True manufacturer part numbers are listed in this column.

Table 4-1. Manufacturers' Code-To-Name Index

Code	Manufacturer Name	Address	Zip Code
00213	Nytronics Components Group Inc.	Darlington, SC	29532
00779	Amp Inc.	Harrisburg, PA	17105
01121	Allen Bradley Co.	Milwaukee, WI	53203
01295	Texas Instruments Inc. Semiconductor Group	Dallas, TX	75265
02114	Amperex Electronic Corp. Ferroxcube Division	Saugerties, NY	12477
02660	Allied Corp. Amphenol Commercial and Industrial Div.	Lisle, IL	60532
02735	RCA Corp Solid State Div.	Somerville, NJ	08876
03508	General Electric Co. Semiconductor Products Div.	Auburn, NY	13021
03877	Gilbert Engineering Co. Inc. Transition Electronic Corp.	Glendale, AZ	85301
04222	AVX Ceramics Div.-AVX Corp.	Myrtle Beach, SC	29577
04713	Motorola Semiconductors Prod. Inc.	Phoenix, AZ	85008

Table 4-1. Manufacturers' Code-To-Name Index — Continued

Code	Manufacturer Name	Address	Zip Code
05245	Corcom Inc.	Libertyville, IL	60048
06540	Amatom Electronic Hardware Division of Mite Corp.	New Haven, CT	06515
06560	Airco Inc. Airco Electronics	Nogales, AZ	85621
06776	Robinson Nugent Inc.	New Albany, IN	47150
06928	Teledyne Kinetics Div of Teledyne Industries Inc.	Solana Beach, CA	92075
07263	Fairchild Camera and Instrument Corp. Semiconductor Div.	Mountain View, CA	94039
08289	Delbert Blinn Co. Inc.	Pomona, CA	91769
08679	Perforated Products Inc.	Brookline, MA	02146
13103	Thermalloy Co.	Dallas, TX	75381
14218	Continental Car-Na-Var Corp.	Brazil, IN	
14752	Electro Cube Inc.	San Gabriel, CA	91776
15542	Mini Circuits Lab Div of Scientific Components Corp.	Brooklyn, NY	11235
15636	Elec-Trol Inc.	Saugus, CA	91350
15912	Thomas and Betts Corp. Electronics Group	Los Angeles, CA	90032
16179	M/A-Com Omni Spectra Inc. Microwave Component Div.	Merrimack, NH	03054
16299	Corning Glass Works	Raleigh, NC	27604
17856	Siliconix, Inc.	Santa Clara, CA	95054
18324	Signetics Corp. Military Products Division	Sacramento, CA	95834
19701	Mepco/Electra Inc.	Mineral Wells, TX	76067
20932	Illinois Tool Works Inc. Emcom Division	San Diego, CA	92121
22526	Berg Electronics Div. of Du Pont	New Cumberland, PA	17070
23936	Pamotor-Div. of William Purdy Co.	Burlingame, CA	94010
24539	Avantek Inc.	Santa Clara, CA	95051
25403	Amperex Electronics Corp.	Slaterville, RI	02876
25426	Rockwell Telecommunications Inc. Wescom Telephone Products Div.	Downers Grove, IL	60515
26654	Varadyne Industries Inc.	Santa Monica, CA	90404
26806	American Zettler Inc.	Irvine, CA	92714
27014	National Semiconductors Corp.	Santa Clara, CA	95051
27264	Molex Inc.	Lisle, IL	60532
28480	Hewlett-Packard Co. Corp.	Palo Alto, CA	94304
28875	IMC Magnetics Corp.	Rochester, NH	03867
29990	American Technical Ceramics Division of Phase Industries	Huntington Station, NY	11746
30146	Symbex Corp. Subsidiary Asso. Enterprises	Painesville, OH	44077
30161	AAVID Engineering Inc.	Laconia, NH	03247
31259	Thurston Tool-Die and Mfg.	San Leandro, CA	91341
31433	Union Carbide Corp. Electronics Division	Greenville, SC	29606
31918	ITT Schadow Inc.	Eden Prairie, NM	55344
32159	West-Cap Arizona	Tucson, AZ	85706
32293	Intersil Inc.	Cupertino, CA	95014
34335	Advance Micro Devices	Sunnyvale, CA	94086
50088	Thomson Components — Mostek Corp.	Carrollton, TX	75006
51642	Centre Engineering Inc.	State College, PA	16801
51870	Cooper Laboratories Inc.	Wayne, NJ	07470
52542	Systron Donner Corp. Instrument Div.	Concord, CA	94518
53387	Minnesota Mining and Mfg. Co. Electronic Products Div.	St. Paul, MN	55101
54453	Sullins Electronic Corp.	San Marcos, CA	92069
55210	Gettig Engineering and Mfr.	Spring Mill, PA	16875

Table 4-1. Manufacturers' Code-To-Name Index — Continued

Code	Manufacturer Name	Address	Zip Code
56289	Sprague Electric Co.	Lexington, MA	02173
57693	Oscillatek Corp.	Olathe, KS	66062
59474	Jeffers Electronics Inc.	Nogales, AZ	85621
60393	Precision Resistive Products Inc.	Mediapolis, IA	52637
60935	Westlake Capacitors Inc. Tantalum Div.	Westlake Village, CA	91361
61162	JFW Industries Inc.	Indianapolis, IN	46237
61725	ITT Components Div. of ITT Corp.	Santa Ana, CA	92705
63155	Synergy Microwave Corp.	Paterson, NJ	07504
70903	Belden Corp.	Geneva, IL	60134
71279	Midland-Ross Corp. Cambion Division	Cambridge, MA	02140
71590	MEPCO/Centralab	Fort Dodge, IA	50501
72136	Electro Motive Corp.	Florence, SC	
72619	Dialight Div. Amperex Electronics Corp.	Brooklyn, NY	11237
72982	Murata Erie North American Inc.	Erie, PA	16512
73138	Beckman Industrial Corp. Beckman Electronics Technologies	Fullerton, CA	92635
73803	Texas Instruments Inc.	Attleboro, MA	02703
74970	E. F. Johnson Co.	Waseca, MN	56093
75037	Minnesota Mining and Mfg Co. Electro Products Division	St. Paul, MN	55101
75378	CTS Knights Inc.	Sandwich, IL	60548
75543	Lavelle Industries Inc.	Chicago, IL	60622
78189	Illinois Tool Works Inc. Shakeproof Division	Elgin, IL	60120
79963	Zierick Mfg. Co.	Mt. Kisco, NY	10549
80205	National Aerospace Standard		
80294	Bourns Instruments Inc.	Riverside, CA	92506
81349	Military Specifications Promulgated by Military Departments/Agencies Under Authority of Defense Standardization Manual 4120 3-M		
82647	Texas Instruments Inc. Control Products Div.	Attleboro, MA	02703
83186	Victory Engineering Corp.	Springfield, NJ	07081
83330	Kulka Smith Inc.	Manasquan, NJ	08736
86928	Seastrom Mfg. Co. Inc.	Glendale, CA	91201
88245	Winchester Electronics Litton Systems — USECO Div.	Van Nuys, CA	91409
91506	Augat Inc. Technical Ceramics Division	Attleboro, MA	02703
91637	Dale Electronics Inc.	Columbus, NE	68601
91836	Kings Electronics Co. Inc.	Tuckahoe, NY	10707
96067	M/A-COM Land Mobile Communications Div. of M/A-COM Inc.	Sunnyvale, CA	94088
96152	Borg-Warner Corp.	Decatur, IL	62525
96733	SFE Technologies	San Fernando, CA	91340
96906	MIL Specifications		
98291	Sealectro Corp. BICC Electronics	Trumbull, CT	06611
99800	American Precision Industries Inc. Delevan Div.	East Aurora, NY	14052
98921	O and M Mfg. Co.	Houston, TX	77029
98978	International Electronic Research Corp.	Burbank, CA	91510

Table 4-2. Replaceable Parts List Index

Title	Reference Number	Page Number
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Model 1502 Shipping Kit Assembly	08352602	4-7
1500 Series Universal Assembly	08350801	4-8
Loop 1 and PROM PC Board Assembly	08351201	4-9
Coax Cable Kit Assembly	08351301	4-10
Chassis Assembly	07728401	4-11
Printed Circuit (PC) Enclosure Assembly	08326401	4-12
Front Panel Assembly	07730901	4-13
Rear Panel Assembly	07729201	4-14
Bottom Cover Assembly	07742701	4-16
Keyboard and Display PC Board Assembly A1	07766001	4-17
Front Panel Interface PC Board Assembly A2	07766101	4-18
Interface PC Board Assembly A3	07760001	4-20
Level Control PC Board Assembly A4	07762001	4-21
AM Audio Synthesizer PC Board Assembly A5A	07736703	4-24
FM Audio Synthesizer PC Board Assembly A5B	07736704	4-26
Downconverter PC Board Assembly A6	07734301	4-28
Loop 1 Output PC Board Assembly A7	07752101	4-31
Loop 1 and Interface PC Board Assembly A8	07735301	4-35
Loops 2 and 9 PC Board Assembly A9	07760201	4-38
Loops 3 and 4 PC Board Assembly A10	07749301	4-43
Divide-by-N and Divide-by-P PC Board Assembly A11	07753201	4-48
Divide-by-Q PC Board Assembly A12	07751501	4-50
Loops 5, 6, and 7 PC Board Assembly A13	07754201	4-52
Reference Frequency Generator PC Board Assembly A14	07743401	4-56
CPU PC Board Assembly A15	07733101	4-60
Power Supply PC Board Assembly A16	07751001	4-61

Table 4-2. Replaceable Parts List Index — Continued

Title	Reference Number	Page Number
Motherboard PC Board Assembly A17	08325601	4-63
Feature 1 Timebase	083514	4-64
TCXO PC Board Assembly	08307501	4-65
High Stability Oscillator (Option 01)	08307502	4-66
Model 1501 Output Module Assembly (Standard)	07790101	4-67
Model 1502 Output Module Assembly (Standard)	07790102	4-68
Model 1501 Output Module Rear Panel Assembly (Option 02)	07790103	4-69
Model 1502 Output Module Rear Panel Assembly (Option 02)	07790104	4-70
Model 1501 Output Module Section 2 Assembly A22	07790301	4-71
Model 1502 Output Module Section 2 Assembly A22	07790302	4-72
Model 1501 Output Module Section 2 Rear Panel Assembly A22 (Option 02)	07790303	4-73
Model 1502 Output Module Section 2 Rear Panel Assembly A22 (Option 02)	07790304	4-74
Leveler/Amplifier Assembly A22A1	08317001	4-75
Leveler Assembly A22A2	10320307	4-76
Model 1502 2500-MHz Amplifier Assembly A22A11	08345501	4-77
Output Module Section 2 PC Board Assembly A22A13	08322601	4-78
Model 1501 Output Module Section 1 Assembly A23	08303101	4-79
Model 1502 Output Module Section 1 Assembly A23	08303102	4-80
Model 1501 Filter/Amplifier Assembly A23A1	08342801	4-81
Model 1502 Filter/Amplifier Assembly A23A1	08342802	4-82
Model 1502 Detector Assembly A23A4	07792601	4-83
Power Distribution PC Board Assembly A24	07794401	4-87
Power Supply Plate Assembly	07776601	4-88

REPLACEABLE PARTS LIST

Title: Model 1501 Shipping Kit Assembly, 08352601

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0005	12007701	MANUAL OPERATORS 1501/02 FREQ SYNTHESIZER		1.000	52542	
0012	07742001	FAB DECORATIVE PANEL		1.000	52542	
0015	077334	FAB FRONT TRIM TOP		1.000	52542	
0016	077403	FAB FRONT TRIM BOTTOM		1.000	52542	
0018	100703	FLAT WSHR #4 .125 ID.250 OD CRES		8.000	96906	MS15795-803
0019	100711	SPLIT LOCK#4 CRES		8.000	96906	MS35338-135
0020	10062603	PHMS CRES 4-40 X 3/16		8.000	96906	MS51957-12
0022	123388	.66H		1.000	08679	RB-67-4A-3501(.2505)
0031	067655	TRIM, SIDE W/HANDLE		2.000	52542	
0032	067440	HANDLE, VINYL,SIDE(2)		2.000	52542	
0033	117804	SPACER .171 IDX.25 ODX.125L SS		4.000	06540	9222-SS-171
0035	10074308	FHMS CRES 8-32 X 1/2		4.000	96906	MS24693-C50
0036	10073107	FHMS CRES 6-32 X 7/16		8.000	96906	MS24693-C27
0044	07742601	ASSY TOP COVER M150X		1.000	52542	
0045	07742701	ASSY BOTTOM COVER		1.000	52542	
0046	10075808	FHMS CRES 10-32 X 1/2		16.000	96906	MS24693-C272
0048	117680	LINE CORD 2M 3X16 NEMA5-15P SPH386		1.000	70903	17502

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 Shipping Kit Assembly, 08352602

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0005	12007701	MANUAL OPERATORS 1501/02 FREQ SYNTHESIZER		1.000	52542	
0012	07742002	FAB DECORATIVE PANEL 1502		1.000	52542	
0015	077334	FAB FRONT TRIM TOP		1.000	52542	
0016	077403	FAB FRONT TRIM BOTTOM		1.000	52542	
0018	100703	FLAT WSHR #4 .125 ID.250 OD CRES		8.000	96906	MS15795-803
0019	100711	SPLIT LOCK#4 CRES		8.000	96906	MS35338-135
0020	10062603	PHMS CRES 4-40 X 3/16		8.000	96906	MS51957-12
0022	123388	.66H		1.000	08679	RB-67-4A-3501(.2505)
0031	067655	TRIM, SIDE W/HANDLE		2.000	52542	
0032	067440	HANDLE, VINYL,SIDE(2)		2.000	52542	
0033	117804	SPACER .171 IDX.25 ODX.125L SS		4.000	06540	9222-SS-171
0035	10074308	FHMS CRES 8-32 X 1/2		4.000	96906	MS24693-C50
0036	10073107	FHMS CRES 6-32 X 7/16		8.000	96906	MS24693-C27
0044	07742601	ASSY TOP COVER M150X		1.000	52542	
0045	07742701	ASSY BOTTOM COVER		1.000	52542	
0046	10075808	FHMS CRES 10-32 X 1/2		16.000	96906	MS24693-C272
0048	117680	LINE CORD 2M 3X16 NEMA5-15P SPH386		1.000	70903	17502

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: 1500 Series Universal Assembly, 08350801 (Figure 5-3)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	07728401	ASSY CHASSIS		1.000	52542	
0007	07760001	ASSY PCB INTERFACE	A3	1.000	52542	
0009	07762001	ASSY PCB LEVEL CONTROL	A4	1.000	52542	
0011	07736703	ASSY PCB AUDIO SYNTHESIZER AM	A5A	1.000	52542	
0013	07736704	ASSY PCB AUDIO SYNTHESIZER FM	A5B	1.000	52542	
0015	07734301	ASSY PCB DOWNCONVERTER	A6	1.000	52542	
0016	08351201	ASSY PCB LOOP 1 & PROM		1.000	52542	
0017	07735301	ASSY PCB LOOP 1 IF	A8	1.000	52542	
0019	07760201	ASSY PCB LOOPS 2 & 9	A9	1.000	52542	
0021	07749301	ASSY PCB LOOPS 3 & 4	A10	1.000	52542	
0023	07753201	ASSY PCB DIVIDE BY N & P	A11	1.000	52542	
0025	07751501	ASSY PCB DIVIDE BY Q	A12	1.000	52542	
0027	07754201	ASSY PCB LOOPS 5,6 & 7	A13	1.000	52542	
0029	07743401	ASSY PCB REF FREQ GENERATOR	A14	1.000	52542	
0031	07733101	ASSY PCB CPU	A15	1.000	52542	
0033	08351301	ASSY COAX CABLE KIT		1.000	52542	
0034	08313601	ASSY CABLE COAX .85 S.R.		1.000	52542	
0035	08327201	ASSY CABLE S/R A7J1-A12J2		1.000	52542	
0037	083261	FAB MODULE TOP		1.000	52542	
0041	12357806	SH MET SCR 4X3/8 TYPE B PH-PAN HD CRES		103.000		MS24622-10

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Loop 1 and PROM PC Board Assembly, 08351201

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	08349201	ASSY EPROM 1501 L0001 COARSE TUNE		1.000	52542	
0003	07752101	ASSY PCB LOOP 1	A7	1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Coax Cable Kit Assembly, 08351301

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0003	08365701	ASSY COAX CABLE		7.000	52542	
0005	08365702	ASSY COAX CABLE		3.000	52542	
0007	08365703	ASSY COAX CABLE		4.000	52542	
0009	08365704	ASSY COAX CABLE		3.000	52542	
0011	08365706	ASSY COAX CABLE		2.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Chassis Assembly, 07728401 (Figure 5-4)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0008	077905	FAB GUSSET R/H		1.000	52542	
0009	083002	FAB RAIL PWR DIST PCB MTG		1.000	52542	
0025	102931	CLAMP CABL .187D .375W .17MTG BLKNYL		1.000	85480	F4NY-187BK
0030	10073104	FHMS CRES 6-32 X 1/4		8.000	96906	MS24693-C24
0035	10063206	PHMS CRES 6-32 X 3/8		4.000	96906	MS51957-28
0036	10063205	PHMS CRES 6-32 X 5/16		14.000	96906	MS51957-27
0037	10063204	PHMS CRES 6-32 X 1/4		5.000	96906	MS51957-26
0038	10063208	PHMS CRES 6-32 X 1/2		1.000	96906	MS51957-30
0039	112472	NUT KEP 6-32 .281OD .11TH CPS		2.000	78189	511-061800-01
0042	10074304	FHMS CRES 8-32 X 1/4		6.000	96906	MS24693-C46
0043	10074305	FHMS CRES 8-32 X 5/16		6.000	96906	MS24693-C47
0046	100712	SPLIT LOCK#6 CRES		21.000	96906	MS35338-136
0047	100486	LUG SOLDER#6INT TOOTH.72L 2HOLE.093		1.000	83330	1413-6
0052	100704	FLAT WSHR 6 .156 ID.312 OD CRES		14.000	96906	MS15795-805
0058	100750	THERML COMPOUND FOR MTG XISTORS & DIODES	A/R	.000	05820	120-8
0060	840192	FEET RUBBER #2095		2.000	52542	
0080	07793501	ASSY CABLE FLAT RIBBON		1.000	52542	
0100	07730901	ASSY FRONT PANEL		1.000	52542	
0102	07729201	ASSY REAR PANEL		1.000	52542	
0104	07776601	ASSY P/S PLATE		1.000	52542	
0106	08326401	ASSY PC ENCLOSURE	(A17)	1.000	52542	
0108	07794401	ASSY PCB POWER DISTRIBUTION	A24	1.000	52542	
0109	07751001	ASSY PCB POWER SUPPLY	A16	1.000	52542	
0115	507728401	W/L CHASSIS ASSY COAX LIST	REF	.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Printed Circuit (PC) Enclosure Assembly, 08326401 (Figure 5-5)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	08325601	ASSY PCB MOTHERBOARD		1.000	52542	
0003	083259	FAB MODIF EXTRUSION		14.000	52542	
0004	083260	FAB MODIF EXTRUSION		16.000	52542	
0005	083257	FAB MODIF EXTRUSION		15.000	52542	
0008	12357806	SH MET SCR 4X3/8 TYPE B PH-PAN HD CRES		103.000		MS24622-10
0010	083267	FAB BAFFLE		1.000	52542	
0011	083265	FAB GUSSET L/H		1.000	52542	
0012	083266	FAB CHASSIS DIVIDER		1.000	52542	
0013	077281	FAB RAIL BD MOUNTING		1.000	52542	
0014	12357804	SH MET SCR 4X1/4 TYPE B PH-PAN HD CRES		30.000		MS24622-8
0015	10063204	PHMS CRES 6-32 X 1/4		13.000	96906	MS51957-26
0016	10063206	PHMS CRES 6-32 X 3/8		7.000	96906	MS51957-28
0017	10073103	FHMS CRES 6-32 X 3/16		9.000	96906	MS24693-C23
0019	100662	FLAT WSHR 6 .146 ID.270 OD CRES		20.000	86928	5710-23-10
0020	100712	SPLIT LOCK#6 CRES		20.000	96906	MS35338-136
0021	100711	SPLIT LOCK#4 CRES		30.000	96906	MS35338-135
0022	101097	FOOT CORK .70 D X.13 H SELF ADHV		12.000	14814	5999-005949

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Front Panel Assembly, 07730901 (Figure 5-6)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	077309	FAB SUB PANEL		1.000	52542	
0002	083162	FAB PANEL BRKT		1.000	52542	
0003	123471	SPACER NYLON .091IDX.187ODX.187L		2.000	83330	9161
0004	102989	SPCR THRDD6-32 3/8LX1/4HEX AL IR		11.000	83330	8422
0005	123468	ADHESIVE ICMPNT HIGH STRENGTH	A/R	.000	76381	271-31
0007	10070007	FHMS CRES 2-56 X 7/16		2.000	80205	NAS662C2R7
0009	10073104	FHMS CRES 6-32 X 1/4		13.000	96906	MS24693-C24
0011	10063214	PHMS CRES 6-32 X 7/8		11.000	96906	MS51957-33
0012	10063204	PHMS CRES 6-32 X 1/4		5.000	96906	MS51957-26
0013	100704	FLAT WSHR 6 .156 ID.312 OD CRES		11.000	96906	MS15795-805
0014	100662	FLAT WSHR 6 .146 ID.270 OD CRES		5.000	86928	5710-23-10
0015	100661	SPLIT LOCK#2 CRES		2.000	96906	MS35337-77
0017	100712	SPLIT LOCK#6 CRES		11.000	96906	MS35338-136
0019	100636	NUT HEX 2-56 .19AF .06THK SS		2.000	96906	MS35649-224
0026	07766001	ASSY PCB KEYBOARD & DISPLAY	A1	1.000	52542	
0027	07766101	ASSY PCB FRONT PANEL INTERFACE	A2	1.000	52542	
0029	08325301	ASSY KEY CAP SET 1500		1.000	52542	
0036	12318501	ASSY DIGITAL POT	R1	1.000	52542	
0041	123365	SW ROCKER DPDT 125/250V 5/2A ON-NONE-ON GRAY	S1	1.000	72619	572-2128-0111-012
0042	507730901	WIRE LIST FRONT PANEL		.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Rear Panel Assembly, 07729201 (Figure 5-7)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707751001	SCHEM PCB POWER SUPPLY	REF	.000	52542	
0002	077292	FAB REAR PANEL		1.000	52542	
0003	077306	FAB HEATSINK		1.000	52542	
0004	507778501	WIRE LIST REAR PANEL		1.000	52542	
0006	112627	GROMMET 5/16MTG 3/16ID BLKVNL.06M		4.000	83330	2146
0007	083235	FAB FAN SCREEN M1500		1.000	52542	
0009	33000322	FILTER HOUSING		1.000	52542	
0010	075803	FILTER AIRM1626		1.000		
0011	100963	GROMMET 3/8MTG 1/4ID .062MAT BLKRUBBER		4.000	83330	2170
0012	116610	SPACER 6 X .188L*.25RND BRASS CAD		4.000	06540	9223B140-3A
0013	075197	SPACER M-F6-32M/M3.5X0.6F .812L BLK		2.000	52542	
0014	100753	TIE CABLE 0-3/4 NAT NYLON 4IN L		1.000	96906	MS3367-4-9
0015	11961001	COVER CFMR 11961002 CD PL MPS90 CLASS2 TYPEII		1.000	52542	
0016	117932	INS XISTORTO-3 STRETCH-ON		2.000		A22-2003
0017	102940	INS XISTORTO-3 MICA.16LD&MTG 1.655L		2.000	08289	DM-103
0018	100750	THERML COMPOUND FOR MTG XISTORS & DIODES	A/R	.000	05820	120-8
0020	10072008	FHMS CRES 4-40 X 1/2		2.000	96906	MS24693-C6
0022	10063205	PHMS CRES 6-32 X 5/16		2.000	96906	MS51957-27
0023	10063207	PHMS CRES 6-32 X 7/16		4.000	96906	MS51957-29
0025	10063210	PHMS CRES 6-32 X 5/8		4.000	96906	MS51957-31
0027	10063212	PHMS CRES 6-32 X 3/4		4.000	96906	MS51957-32
0028	10063216	PHMS CRES 6-32 X 1		4.000	96906	MS51957-34
0030	10064244	PHMS CRES 8-32 X 2 3/4 PHILLIPS		4.000		MS51957-56
0034	100703	FLAT WSHR #4 .125 ID.250 OD CRES		2.000	96906	MS15795-803
0036	112604	FLAT WSHR 6 .147ID .3750D .03T BR NP		8.000	86928	5714-34-32N
0037	123538	FLAT WSHR #6 .153IDX.5000D .040TH CRES		4.000	86927	5710-26-40
0038	100705	FLAT WSHR 8 .187 ID.375 OD CRES		8.000	96906	MS15795-807
0040	112621	NYLON WSHRSHLDR 8 .174ID.3750D.09TH		8.000	86928	5607-91
0044	100712	SPLIT LOCK#6 CRES		10.000	96906	MS35338-136
0047	100638	NUT HEX 6-32 .25AF .09THK STST		2.000	80205	NAS671C6
0048	100941	NUT KEP 4-40 .2810D .11THK CPS		2.000	78189	511-041800-00
0049	112472	NUT KEP 6-32 .2810D .11TH CPS		8.000	78189	511-061800-01
0050	100940	NUT KEP 8-32 .3750D .16THK CPS		4.000	78189	511-081800-00
0054	107077	LUG SOLDER.38INTL T .025BRZ .59L TN		4.000	79963	814
0062	08323701	ASSY DC FAN PREP 1501	B1	1.000	52542	
0064	100082	CAP TANT 1UF 35V 10% AX LEAD	C3,5,12	4.000	56289	150D105X9035A2
0064	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	14	.000		
0065	106523	CAP TANT 10UF 35V 10% AX LEAD EL	C4,13	2.000	01295	SCM106GP035B2
0070	860070	TERM SCWMT 6-32 BIFURCATED .08W .63H 8KV	E1,2	2.000	17117	3340-14-1
0079	101155	RECEPT RF BNC UG-1094/U FRONT "D" MTG SHORT	J4,5,7	3.000		UG-1094/U
0081	11940601	RECEPT PLZ SHLD 2COND BNC SHELL ISKT 1PIN	J6	1.000	02660	31-2225
0083	08310301	ASSY IEEE CABLE	J8	1.000	52542	
0085	102065	RES MF 221 .1 W 1% 100PPM	R1	1.000		RN55D2210F
0086	106228	RES MF 243 .12W 1% 100PPM	R8	1.000	16299	NA60
0087	102252	RES MF 750 .12W 1% 100PPM	R2	1.000	91637	MFF 1/8 T1
0090	102068	RES MF 1.02K .1W 1% 100PPM	R9	1.000		RN55D1021F

REPLACEABLE PARTS LIST — Continued

Title: Rear Panel Assembly, 07729201 (Figure 5-7) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0095	07731201	ASSY XFMR PREP 1501	T1	1.000	52542	
0096	123180	IC VOLTREG LM338K 1.2-32V@5A TO-3 0 TO 125C	U1	1.000	27014	LM338K
0098	123181	IC VOLTREG LM333K -1.2/-33V@3A TO-3 0 TO 125C	U4	1.000	27014	LM333K
0100	114088	SCKT TO-3 MD-3452-G DIALLYL PHTHALATE	XU1,4	2.000		MD-3452-G
0104	11993601	FILTER RFI6A FUSED,LINE SW	FL1	1.000	05245	6J4

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Bottom Cover Assembly, 07742701 (Figure 5-8)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0003	077427	FAB BOTTOM COVER		1.000	52542	
0004	067499	BAIL		1.000	52542	067499
0005	067498	FOOT STACKING		4.000		
0007	10073108	FHMS CRES 6-32 * 1/2		8.000	96906	MS24693-C28

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Keyboard and Display PC Board Assembly A1, 07766001 (Figure 5-10)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	607766101	BLOCK DIAGRAM DISPLAY INTERFACE	REF	.000	52542	
0002	707766101	SCHEM PCB FRONT PANEL INTERFACE	REF	.000	52542	
0003	2077660	ARTWORK PCB KEYBOARD & DISPLAY	REF	.000	52542	
0005	077660	FAB PCB KEYBOARD & DISPLAY		1.000	52542	
0006	083106	FIXTURE ASSY AID A1 PCB	REF	.000	52542	
0007	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C1-3	3.000	96733	DB44BY100J
0008	106514	CAP TANT 47UF 20V 20%	C4,5	2.000	56289	196D476X0020PE4
0011	117211	CON PC PIN2*10 HEADER .025SQ .1C-C	P1-7	7.000	30146	922584-20
0013	116486	LED RED 6V 120MA 8 PIN SIP BAR	DS1-5	5.000	28480	HLMP-2350
0014	123404	LED LOGHT BAR RED 4PIN SIP .195W.400L.245H	DS6-27	22.000	28480	HLMP 2300
0016	123112	LED RECT. GREEN .8MCD@20MA .08W * .2L * .3H	DS29,30	11.000		SPG 5531 REC
0016	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	DS32,33	.000		
0016	99REF02	************ REF DESN'TORS CONT *************	DS35-37	.000		
0016	99REF03	************ REF DESN'TORS CONT *************	DS39-42	.000		
0021	123113	LED,RECT. RED .8NCD@20MA .08W * .2L * .3H	DS28,31	6.000		SPR 5531 REC
0021	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	DS34,38	.000		
0021	99REF02	************ REF DESN'TORS CONT *************	DS43,44	.000		
0025	123070	SW, PB SNGL UNLIGHTED MOMENTARY	S1-S48	48.000		15.500
0028	123145	DSPL LCD 4DIG 7SEG W/CURSER REFLECT.AG BKGND	U1	1.000	52542	3.5 24 SDX
0029	123146	DSPL LCD 10DIG 7SEG W/CURSER REFLECT.AG BKGND	U3	1.000	52542	3.5 20-10 SDX
0030	123147	DSPL LCD 3.5DIG 7SEG S/CURSER REFLEC.AG BKGND	U2	1.000	52542	3.5 23-05 SDX
0032	119760	IC CMOS 4DIGIT 7SEG LCD DRIVER	U5-8	4.000	32293	ICM7211AMIPL
0033	119762	IC CMOS MC14543 7SEG LCD DRIVER	U9,10	2.000	04713	MC14543BP
0036	123148	CONN LCD 20 PIN	XU1,3	4.000	06928	5420U020CU
0038	123149	CONN LCD 40PIN	XU2	2.000	06928	S420U040CU
0039	123150	CONN LCD 8 PIN	XU2	2.000	06928	5420U008CU
0041	123399	SCKT DISPL STRIP-LINE 20PIN 3 WRAP	XU1,3	4.000	51167	20-501-30
0043	12340001	FAB 24PIN SCKT STRIP-LINE	XU2	4.000	52542	
0045	123397	SCKT DISPL STRIP-LINE 4 PIN 3 WRAP	XDS6-27	22.000	51167	4-0501-30
0048	123398	SCKT DISPL STRIP-LINE 8 PIN 3 WRAP	XDS1-5	5.000	51167	8-0501-30

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Front Panel Interface PC Board Assembly A2, 07766101 (Figure 5-11)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707766101	SCHEM PCB FRONT PANEL INTERFACE	REF	.000	52542	
0003	2077661	A/W PCB FRONT PANEL INTERFACE	REF	.000	52542	
0005	077661	FAB PCB FRONT PANEL INTERFACE		1.000	52542	
0007	607766001	BLOCK DIAGRAM A1	A1,A2	.000	52542	
0009	117640	CAP CER DP 27PF 100V 5% COG .1LS <.15	C1,2	2.000	96733	DB44BY270J
0010	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C3	1.000	56289	2C37Z5U105M050B
0013	117570	CAP CER DP .01 UF 100V 20% X7R	C4,32,33	19.000	04222	SR201C103MAA
0013	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C12,13,	.000		
0013	99REF02	************ REF DESN'TORS CONT *************	14-27	.000		
0015	117638	CAP CER DP680PF 100V 5% COG .1LS<.2	C6	1.000	96733	DB45BY681J
0020	100224	CAP TANT 47UF 6V 10%	C11	1.000	56289	150D476X9006B2
0021	117639	CAP CER DP 1000PF 5% 100V COG .1LS <.25Q	C28,29	2.000	96733	DB45BY102J
0022	117628	CAP CER DP100PF 100V 5% COG .1LS<.1	C30,31	2.000	96733	DB44BY101J
0023	106514	CAP TANT 47UF 20V 20%	C34,35	2.000	56289	196D476X0020PE4
0024	100385	DIODE SGN1N4151 50V	CR1	1.000	03508	1N4151
0029	11964701	CON PC PIN 2*13 RTANG HDR.1C-C W/LOCKS	J8	1.000	75037	3429-1203
0030	118746	CON PC PIN2*10SKT .025SQ@.1C-C	J1-7	7.000	22526	65781-046
0031	123394	CON PC PIN 2*5 RTANG HDR .1C-C W/EJECTOR-LOCK	J10	1.000	53387	3446-1202
0033	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q1,2	2.000	04713	2N3904
0036	101792	RES CC 1/8W 4.7K 5%	R1,2,8,9	4.000	01121	BB4725
0040	101955	RES CC 1/8W 470K 5%	R3	1.000	01121	BB4745
0042	101713	RES CC 1/8W 3.3K 5%	R5,6	2.000	01121	BB3325
0044	101739	RES CC 1/8W 39K 5%	R7,13	2.000	01121	BB3935
0046	101697	RES CC 1/8W 10K 5%	R15,16	2.000	01121	BB1035
0047	116199	RES CC 1/8W 20K 5%	R14	1.000	01121	BB2035
0050	119255	RES MODULE 9-10K 2% .25W/R 10SIP 100PPM/C .35	RN1,4	2.000	01121	410103
0052	119765	RES MODULE 9-4.7K 2% .25W/R 10SIP 100PPM/C	RN2,3,5	5.000	01121	410A472
0052	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	RN6,7	.000		
0055	117899	SW PB SNGLN.O. PCMT.5SQ MDP W/AG CONT W/O BUT	S1	1.000	31918	210272
0057	112294	FERRITE BEAD .1380D .047ID .118L BS=2900GAUSS	L1	1.000	02114	56-590-65/4A
0058	116322	IC TTL MSI74LS138 3-8LINE DECODER	U1,9,17	6.000	27014	DM74LS138N
0058	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	18,29,53	.000		
0061	103749	IC TTL SSI74LS04 HEX INV <20NS	U2,8,19	6.000	01295	SN74LS04N
0061	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	28,40,55	.000		
0067	116210	IC CMOS EXCLUSIVE OR GATES	U3,5	10.000	04713	MC14070BCP
0067	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	24-27,41	.000		
0067	99REF02	************ REF DESN'TORS CONT *************	57-59	.000		
0072	117257	IC CMOS LS4508 2*4BIT LATCH 24DIP	U4,35,56	3.000	04713	MC14508BCP
0074	116556	IC TTL MSI74LS374 8 D EDG-TRG F/F	U6	1.000	01295	SN74LS374N
0076	045208	IC LIN NE555V TIMER WIDE-RANGE 500MA MAX IOUT	U7	1.000	18324	NE555V
0078	116285	IC MC6802 1MHZ 8BIT MPU,CLOCK,RAM 40DIP .6W	U10	1.000	04713	MC6802P
0080	103972	IC TTL SSI74LS32 4 2-IN OR	U11,21	4.000	01295	SN74LS32N
0080	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	U22,39	.000		
0083	118750	IC MICMPTRPROGRAMABLE TIMER	U12	1.000	04713	MC6840P
0085	119959	IC STAT RAM 2K*8 24DIP ZEROPOWER (INT BATT)	U13	1.000	50088	MK48Z02B-25
0087	08315701	ASSY EPROM PROG 150X KEYBD A2	(U14,15)	1.000	52542	

REPLACEABLE PARTS LIST — Continued

Title: Front Panel Interface PC Board Assembly A2, 07766101 (Figure 5-11) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0091	103132	IC TTL 74LS74A DUAL D F/F W/SET&CLEAR	U16,23	2.000	01295	SN74LS74N
0093	117249	IC TTL MSI74LS157 4*2:1LINE MUX ^IN	U20,46	2.000	01295	SN74LS157N
0097	103976	IC TTL SSI74LS123 DUAL RETRIG ISHOT	U30	1.000	01295	SN74LS123N
0099	103967	IC TTL SSI74LS08 4 2-IN AND	U31	1.000	01295	SN74LS08N
0101	103974	IC TTL MSI74LS85 4BIT MAGTD CMPR	U32,45	2.000	01295	SN74LS85N
0103	123040	IC CMOS MSI4514 4BIT LATCH/4-16LIN DEC ACT HI	U33,34	2.000	04713	MC14514BCP
0105	117955	IC TTL MSI74LS245 8 3ST XCUR ^INV	U36,37	2.000	01295	SN74LS245
0109	117508	IC TTL MSI74LS244 8BFR 2ENBL LINEDR	U42,63	2.000	01295	SN74LS244N
0111	116519	IC TTL RAM74S189 16*4 3ST	U43,48	2.000	01295	SN74S189N
0112	11984401	IC TTL 74LS240 8 INV 3ST BUFF/LINE DRVR 20DIP	U44	1.000	01295	SN74LS240N
0114	117952	IC CMOS ICM7218EIJL 8DIG LED DRVR SYS	U47,52	2.000	32293	ICM7218EIJL
0116	103942	IC CMOS LS14512 8CHAN DATA SEL 16DI	U49	1.000	04713	MC14512BCP
0118	045286	IC CMOS 4028 BCD-DEC DCD >1LS	U50	1.000	04713	MC14028BCP
0120	119758	IC MICMPTR SCN2671 MATRIX KYBRD INTFC	U51	1.000	18324	SCN2671AC1N40
0121	117533	IC CMOS 14175B 4D F-F	U54	1.000	04713	MC14175BCP
0122	103199	IC CMOS 4013 DUAL D F/F,IN D,CLK,	U60	1.000		MC14013BCP
0124	117113	IC CMOS MS4516 BIN UP/DOWN CNTR >3M	U61,62	2.000	04713	MC14516BCP
0126	118711	IC TTL SSI74LS221 2*MONOST MULTIVIB	U64	1.000	01295	SN74LS221N
0130	116286	CRYSTAL 4 MHZ	Y1	1.000	75378	MP040
0132	119759	CRYSTAL 4.9152MHZ C+D	Y2	1.000	75378	MP042
0134	117159	SOCKET IC 40PIN .7W(.6SP)X.2.02L<.160H SN CON	XU10	1.000	71279	703-1340-01-04-10
0136	116143	SOCKET IC 28PIN .7W(.6SP)X1.42L <.160H SN CON	XU14,15	2.000	71279	703-1328-01-04-10
0137	116196	SPCR SWAGE6 .06MAT .50L .25DIA ALUM		6.000	71279	350-7404-13-19

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Interface PC Board Assembly A3, 07760001 (Figure 5-14)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707760001	SCHEM PCB INTERFACE		.000	52542	
0002	2077600	ARTOWRK PCB INTERFACE		.000	52542	
0003	077600	FAB PCB INTERFACE		1.000	52542	
0004	607760001	BLOCK DIAGRAM INTERFACE	REF	.000	52542	
0007	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C1	1.000	56289	2C37Z5U105M050B
0008	100178	CAP CER DP .1UF 50V 20% Z5U .38LS .36HI .3SQ	C2-4	3.000	56289	2C37Z5U104M050B
0009	103716	CAP TANT 1UF 35V 10%	C5	1.000	56289	196D105X9035HA1
0010	117570	CAP CER DP .01 UF 100V 20% X7R	C6-9	4.000	04222	SR201C103MAA
0011	117569	CAP CER DP4700PF 100V 20% X7R <.2SQ	C10	1.000	04222	3418100C472M
0012	101615	RES CC 1/4W 150 OHMS 5%	R1	1.000	01121	CB1515
0013	101581	RES CC 1/4W 1.2K 5%	R2	1.000	01121	CB1225
0016	101552	RES CC 1/4W 15K 5%	R3	1.000	01121	CB1535
0017	101559	RES CC 1/4W 3.3K 5%	R4	1.000	01121	CB3325
0019	119175	RES MODULE 9@12K .25W/R 10SIP 100PPM/C .35HI	RN1	1.000	01121	410A123
0023	100385	DIODE SGN1N4151 50V	CR1	1.000	03508	1N4151
0024	100383	DIODE ZENR 15V 5% .4W 1N965B	CR2	1.000	04713	1N965B
0025	100443	DIODE SGNL1N4829 20V 1.87V FWD	CR3	1.000	03508	1N4829
0026	103974	IC TTL MSI74LS85 4BIT MAGTD CMPR	U1	1.000	01295	SN74LS85N
0027	116322	IC TTL MSI74LS138 3-8LINE DECODER	U2	1.000	27014	DM74LS138N
0028	103749	IC TTL SSI74LS04 HEX INV <20NS	U3,4	2.000	01295	SN74LS04N
0030	117955	IC TTL MSI74LS245 8 3ST XCUR ^INV	U5	1.000	01295	SN74LS245
0032	116556	IC TTL MSI74LS374 8 D EDG-TRG F/F	U6-10,14	8.000	01295	SN74LS374N
0032	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	U17,19	.000		
0033	123037	DAC IC AD7533KN 10BIT MULTI 0.1% LIN (1LSB)	U11	1.000	24335	AD7533KN
0034	11886801	IC VOLTREF AD581JH 10.00V +-30MV 30PPM/C	U12	1.000	24335	AD581JH
0035	117703	IC OP AMP TL072 2JFET A68DB 10UV/C	U13	1.000	01295	TL072CP
0036	103198	IC OP AMP LM324 QUAD A1E5 IBLT.5UA	U15,16	3.000	27014	LM324N
0036	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	U18	.000		
0037	117558	IC LIN MSC MC1413 DRIVER 7*50V/.5A NPN DARLIN	U20	1.000	04713	MC1413P
0038	117508	IC TTL MSI74LS244 8BFR 2ENBL LINEDR	U21	1.000	01295	SN74LS244N
0042	101396	XSTR SINPNMPS-A12 DARLINGTON	Q1	1.000	04713	MPS-A12
0045	119764	RELAY REED 5V 500 OHM COIL 1FB .5A@100V DIP	K1	1.000	05636	RA30511051
0047	11964701	CON PC PIN 2*13 RTANG HDR.1C-C W/LOCKS	J1	1.000	75037	3429-1203
0049	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0051	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0053	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0054	08326203	FAB MODULE TOP A3	A3	1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Level Control PC Board Assembly A4, 07762001 (Figure 5-17)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707762001	SCHEM PCB LEVEL CONTROL	REF	.000	52542	
0002	2077620	A/W PCB LEVEL CONTROL	REF	.000	52542	
0003	077620	FAB PCB LEVEL CONTROL		1.000	52542	
0004	607762001	BLOCK DIAGRAM LEVEL CONTROL	REF	.000	52542	
0006	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C1,2,4,	32.000	56289	2C37Z5U105M050B
0006	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	6-10,12,	.000		
0006	99REF02	************ REF DESN'TORS CONT *************	13,15,16	.000		
0006	99REF03	************ REF DESN'TORS CONT *************	21-25,	.000		
0006	99REF04	************ REF DESN'TORS CONT *************	27-33	.000		
0006	99REF05	************ REF DESN'TORS CONT *************	48-55	.000		
0007	117640	CAP CER DP 27PF 100V 5% COG .1LS <.15	C3,56	2.000	96733	DB44BY270J
0012	100155	CAP C MOLD .1 UF 50V 10%	C14,17,	8.000	32159	G505BX104K
0012	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	19,34,	.000		
0012	99REF02	************ REF DESN'TORS CONT *************	37-39,58	.000		
0015	117639	CAP CER DP 1000PF 5% 100V COG .1LS <.25Q	C18,59	2.000	96733	DB45BY102J
0016	117570	CAP CER DP .01 UF 100V 20% X7R	C20	1.000	04222	SR201C103MAA
0018	103291	CAP CER DP820PF 50V 5% COG .2LS <.25SQ	C26	1.000	96733	DG445BY71J
0021	117635	CAP CER DP270PF 100V 5% COG .1LS<.2	C35	1.000	96733	DB45BY271J
0025	117675	CAP CER DP390PF 100V 5% COG .1LS<.2	C36	1.000	96733	DB45BY391J
0028	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C41	1.000	96733	DB44BY100J
0031	106514	CAP TANT 47UF 20V 20%	C42,45	2.000	56289	196D476X0020PE4
0033	103716	CAP TANT 1UF 35V 10%	C43,44,	4.000	56289	196D105X9035HA1
0033	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	46,47	.000		
0043	100390	DIODE ZENR 12V .4W 5% 1N963B	CR1-3,4,	5.000	04713	1N963B
0043	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	28	.000		
0044	100395	DIODE ZENR 10V .4W 5% 1N961B	CR27	1.000	04713	1N961B
0046	100385	DIODE SGN1N4151 50V	CR5,6,7,	11.000	03508	1N4151
0046	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	8-10,12,	.000		
0046	99REF02	************ REF DESN'TORS CONT *************	13-15,29	.000		
0049	100440	DIODE SGNL1N4830 20V 2.69V FWD	CR11	1.000	03508	1N4830
0052	100442	DIODE SIGL HP-2800 70V 100PS ULTRA FAST SW	CR17-20,	7.000	28480	5082-2800
0052	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	23,25	.000		
0058	100378	DIODE ZENR 5.1V .4W 5% 1N751A	CR30	1.000	03877	1N751A
0061	99REF50	******* REF DESN'TORS NOT USED **************	CR33-35	.000		
0067	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-6	6.000	98291	51-053-0000
0071	101320	INDUCT FXD100UH 10% 43QMIN .12X.33	L1	1.000	00213	WEE-WEE-100
0075	103347	JFET PCHAN 2N3993 25V RDS<150 IDSS>1 TO18 4LD	Q1	1.000	04713	2N3993
0079	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q2,5,7	3.000	04713	2N3904
0081	101378	XSTR SI PNP 2N3906 40V 100B300@10MA TO-92	Q3,6	2.000	04713	2N3906
0084	101396	XSTR SINPNMPS-A12 DARLINGTON	Q4	1.000	04713	MPS-A12
0089	101758	RES CC 1W 620 OHMS 5%	R1	1.000	01121	GB6215
0091	117757	RES MF 1.00K .1W 1% 100PPM <.28	R2-5,16,	8.000		C=RN55D1001F
0091	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	71,95,	.000		
0091	99REF02	************ REF DESN'TORS CONT *************	104	.000		
0095	102183	POT 15T PC 500 OHMS 3/8W 10% CERM ENDADJ	R6,7	2.000	73138	89PR500
0097	118983	RES MF 2.87K .1W 1% 25PPM/C <.14	R28	1.000	91637	CMF-55 T9

REPLACEABLE PARTS LIST — Continued

Title: Level Control PC Board Assembly A4, 07762001 (Figure 5-17) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0098	118984	RES MF 2.94K .1W 1% 25PPM/C <.14	R8	1.000	91637	CMF-55 T9
0099	119019	RES MF 6.34K .1W 1% 25PPM/C <.14	R9	1.000	91637	CMF-55 T9
0100	119060	RES MF 15.8K .1W 1% 25PPM/C <.14	R10,11	2.000	91637	CMF-55 T9
0102	102098	RES MF 10.0K .12W 1% 100PPM	R12,13,	12.000	19701	MF5C-D-1002-F
0102	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	24,52,68	.000		
0102	99REF02	************ REF DESN'TORS CONT *************	56,60,70	.000		
0102	99REF03	************ REF DESN'TORS CONT *************	78,82,90	.000		
0102	99REF04	************ REF DESN'TORS CONT *************	91	.000		
0105	101569	RES CC 1/4W 1.0K 5%	R14,33,	4.000	01121	CB1025
0105	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	69,106	.000		
0107	119172	RES MF 1.00M .1W 1% <25PPM/C <.1	R15	1.000	91637	CMF-55 T9
0113	101558	RES CC 1/4W 100K 5%	R17,32,	5.000	01121	CB1045
0113	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	113-115	.000		
0116	102069	RES MF 4.87K .1 W 1% 100PPM	R18,19	2.000	19701	MF4C-D-4871-F
0118	116600	RES MF 887 .1W 1% 100PPM <.28L*	R20	1.000		RN55D8870F
0120	118971	RES MF 2.26K .1W 1% 25PPM/C <.14	R21	1.000	91637	CMF-55 T9
0122	119102	RES MF 38.3K .1W 1% 25PPM/C <.14	R22	1.000	91637	CMF-55 T9
0125	119092	RES MF 30.1K .1W 1% 25PPM/C <.14	R23,58	2.000	91637	CMF-55 T9
0126	116980	RES MF 5.11K .1W 1% 50PPM <.14D*	R102	1.000	16299	NC55 5.11K 1%
0126	119072	RES MF 20.0K .1W 1% 25PPM/C <.14	R25,59,	3.000	91637	CMF-55 T9
0126	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	81	.000		
0128	102086	RES MF 100 OHM .12W 1% 100PPM	R26,27,	6.000	91637	CMF-60 T1
0128	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	38,39,96	.000		
0128	99REF02	************ REF DESN'TORS CONT *************	97	.000		
0131	101597	RES CC 1/4W 68K 5%	R29	1.000	01121	CB6835
0133	101552	RES CC 1/4W 15K 5%	R30,31	2.000	01121	CB1535
0135	117576	RES MF 4.99K .1W 1% 100PPM <.28	R34,35,	4.000		C=RN55D4991F
0135	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	37,72	.000		
0137	119033	RES MF 8.45K .1W 1% 25PPM/C <.14	R36	1.000	91637	CMF-55 T9
0139	101769	RES CC 1/4W 270K 5%	R40	1.000	01121	CB2745
0141	101602	RES CC 1/4W 1.8K 5%	R41-43	3.000	01121	CB1825
0142	101623	RES CC 1/4W 180K 5%	R43	1.000	01121	CB1845
0143	101570	RES CC 1/4W 10K 5%	R45,47,	7.000	01121	CB1035
0143	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	48,74-77	.000		
0144	117810	RES MF 2.49K .1 W 1% 100PPM <.28	R44,61	2.000		C=RN55D2491F
0145	101558	RES CC 1/4W 100K 5%	R46	1.000	01121	CB1045
0147	101598	RES CC 1/4W 4.7K 5%	R49,50	2.000	01121	CB4725
0148	102170	RES MF 4.22K .25W 1% 100PPM	R51	1.000	91637	MFF 1/8 T1
0149	102195	RES MF 1.62K .12W 1% 100PPM	R53	1.000	91637	MFF-1/8 T1
0150	102094	RES MF 6.65K .12W 1% 100PPM	R54	1.000	19701	MF5C-D-6651F
0151	119001	RES MF 4.32K .1W 1% 25PPM/C <.14	R55,73	2.000	91637	CMF-55 T9
0152	117587	RES MF 909 .1 W 1% 100PPM <.28L*	R62	1.000		C=RN55D9090F
0153	11974801	RES MF 75.0 .1W 1% 100 PPM	R63	1.000	91637	CMF55 T1
0154	11974501	RES MF 26.1 .1W 1% 100 PPM	R64	1.000	91637	CMF55 T1
0155	11982901	RES MF 118 .1W 1% 100PPM/C <.14D*.28L	R65	1.000	91637	CMF 55 TI
0156	106320	RES MF 402 .12W 1% 100PPM	R66	1.000		RN60D4020F

REPLACEABLE PARTS LIST — Continued

Title: Level Control PC Board Assembly A4, 07762001 (Figure 5-17) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0157	118976	RES MF 2.55K .1W 1% 25PPM/C <.14	R83	1.000	91637	CMF-55 T9
0158	123144	RES MF 619 .1W 1% 25PPM/C<.14D * .281L	R84	1.000	91637	CMF-55 T9
0159	103087	RES MF 90.9 1% .13W@125C 100PPM	R85	1.000	91637	MFF 1/8 T1
0160	103194	RES MF 806 1% .12W@125C 100PPM	R86	1.000	91637	CMF-60 T1
0161	117588	RES MF 33.2 .1 W 1% 100PPM <.28L	R87	1.000		C=RN55D33R2F
0163	102879	JUMPER, 22AWG INSULATED .09D .25L	R88,89,	3.000	55210	L-2007-1
0163	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	67	.000		
0165	119026	RES MF 7.50K .1W 1% 25PPM/C <.14	R92	1.000	91637	CMF-55 T9
0168	117589	RES MF 100 .1 W 1% 100PPM <.28L*	R93,116,	3.000		C=RN55D1000F
0168	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	119	.000		
0169	101584	RES CC 1/4W 5.6K 5%	R94	1.000	01121	CB5625
0170	101696	RES CC 1/4W 22 OHMS 5%	R97	1.000	01121	CB2205
0171	101609	RES CC 1/4W 100 OHMS 5%	R98	1.000	01121	CB1015
0172	101576	RES CC 1/4W 33K 5%	R99	1.000	01121	CB3335
0173	101656	RES CC 1/2W 820 OHMS 5%	R100	1.000	01121	EB8215
0175	119941	RES MF 200 .1W 1% 25PPM	R101	1.000		C=RN55E2000F
0177	101567	RES CC 1/4W 820 OHMS 5%	R103	1.000	01121	CB8215
0178	103088	RES MF 1.07K 1% .13W@125C,25PPM	R105	1.000	91637	MFF 1/8 T9
0179	101625	RES CC 1/4W 470 OHMS 5%	R107	1.000	01121	CB4715
0180	101871	RES CC 2W 51 OHMS 5%	R108	1.000	01121	HB5105
0181	101855	RES MF 1.21K .1 W 1% 25PPM	R109,111	2.000	19701	MF4C-E-1211-F
0183	101784	RES CC 1/4W 2.7 OHMS 5%	R110,112	2.000	01121	CB27G5
0185	101605	RES CC 1/4W 1.0M 5%	R117,118	2.000	01121	CB1055
0186	101577	RES CC 1/4W 1.5K 5%	R120	1.000	01121	CB1525
0188	117250	IC CMOS MSI IH5043 2*SPDT R<80 10V MAX INPUT	U1,3	2.000	32293	IH5043CPE
0190	117703	IC OP AMP TL072 2JFET A68DB 10UV/C	U2	1.000	01295	TL072CP
0192	11940501	IC LIN LM339A QUAD COMP EO<2MV IB<.25UA 14DIP	U4,12	2.000	27041	LM339AN
0195	119966	DAC IC 12BIT 4QUAD MULT CMOS	U5	1.000	24335	AD7541AJN
0197	117703	IC OP AMP TL072 2JFET A68DB 10UV/C	U8	1.000	01295	TL072CP
0199	118871	DIODE REF LM329A 7.25/6.6V@.6-15MA	U7	1.000	27014	LM329AH
0201	118742	IC OP AMP A88DB IB1.5UA <7NV/(HZ)E.5 10MHZ	U9	1.000	18324	NE5534AN
0203	123424	IC LIN MSC IH5053C QUAD SPST NO CMOS SWITCH	U10	1.000	32293	IH5053CJE
0205	119975	IC OP AMP 5532 DUAL LOW NOISE	U11,13,	4.000	18324	NE5532AN
0205	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	14,6	.000		
0211	123392	IC LIN SAMPLE HOLD AD583 14PIN DIP	U15	1.000	24335	AD583KD
0213	103130	IC TTL SSI74LS00 QUAD 2IN NAND GATE	U16	1.000	01295	SN74LS00N
0215	118711	IC TTL SSI74LS221 2*MONOST MULTIVIB	U17	1.000	01295	SN74LS221N
0217	025783	IC LIN MSC 719 DIFF V COMP 8L TO-5	U18	1.000	07263	UA710HC
0217	99REF92	IC LIN MSC 719 DIFF V COMP 8L TO-5	U18	.000		
0221	123408	IC LIN MPQ6002 QUAD NPN XSTR 25V	U20	1.000	04713	MPQ6002
0230	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0231	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0232	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0233	08326204	FAB MODULE TOP A4		1.000	52542	
0234	100575	TERM PRESSFDTH .086MTG .06MAT .515L		3.000	98921	001-1007

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: AM Audio Synthesizer PC Board Assembly A5A, 07736703 (Figure 5-20)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	7077367TAB	SCH PCB AUDIO SYNTH	REF	.000	52542	
0002	607736701	BLOCK DIAGRAM AUDIO SYNTHESIZER A4	REF	.000	52542	
0003	2077367	A/W PCB AUDIO SYNTHESIZER AM	REF	.000	52542	
0004	077367	FAB PCB AUDIO SYNTHESIZER AM		1.000	52542	
0007	103974	IC TTL MSI74LS85 4BIT MAGTD CMPR	U1	1.000	01295	SN74LS85N
0008	116322	IC TTL MSI74LS138 3-8LINE DECODER	U2	1.000	27014	DM74LS138N
0009	117955	IC TTL MSI74LS245 8 3ST XCUR ^INV	U3	1.000	01295	SN74LS245
0011	103749	IC TTL SSI74LS04 HEX INV <20NS	U5	1.000	01295	SN74LS04N
0012	117508	IC TTL MSI74LS244 8BFR 2ENBL LINEDR	U6	1.000	01295	SN74LS244N
0013	116556	IC TTL MSI74LS374 8 D EDG-TRG F/F	U7-10	4.000	01295	SN74LS374N
0016	117514	IC TTL SSI74LS38 QUAD 2IN OPN COL B	U12	1.000	01295	SN74LS38N
0017	045207	IC TTL MSI74167 DECADE RATE MULT	U13-16	4.000	01295	SN74167N
0018	045296	IC TTL SSI7425 DUAL 4IN NOR W/STROB	U17	1.000	01295	SN7425N
0019	103164	IC TTL MSI74LS196 PRST BCD CNTR 2,5	U18	1.000	01295	SN74LS196N
0020	116526	IC TTL 74LS490 DUAL DEC CNTR >40MHZ SET9&CLR0	U19	1.000	01295	SN74LS490AN
0021	116162	IC TTL MSI74LS151 8BIT DATA SEL	U20	1.000	01295	SN74LS151N
0022	117871	IC TTL MSI74LS160 SYN,PRESET, DCLR	U21,22	2.000	01295	SN74LS160AN
0023	08315401	ASSY PROM PROGRAMED	U23	1.000	52542	
0024	123029	DAC IC DAC0800LCN 8 BIT COMP CUREENT OUTPUTS	U24	1.000	27014	DAC0800LCN
0025	123393	IC OP AMP TL071 JFET LOW NOISE 10UV/C	U25,28	2.000	01295	TL071CP
0026	118743	IC CMOS 14051 8-1 ANALOG MULTIPLE	U26	1.000	04713	MC14051BCP
0027	123037	DAC IC AD7533KN 10BIT MULTI 0.1% LIN (1LSB)	U27	1.000	24335	AD7533KN
0029	117013	IC VOLTREG78L12 12.5/11.5V .07A 92	U29	1.000	04713	MC78L12ACP
0030	117555	IC VOLTREG79L12 -12.5/11.5 40MA TO9	U30	1.000	04713	MC79L12ACP
0036	117349	XSTR SIPNPMPS-A63 30V H>5K@10MA	Q2	1.000	04713	MPS-A63
0040	100385	DIODE SGN1N4151 50V	CR1,4	2.000	03508	1N4151
0042	100377	DIODE REF 6.2V .01%/C 1N821	VR1	1.000	04713	1N821
0045	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C2,5,9,	8.000	56289	2C37Z5U105M050B
0045	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	10,19,24	.000		
0045	99REF02	************ REF DESN'TORS CONT *************	45,46	.000		
0049	100155	CAP C MOLD .1 UF 50V 10%	C3,12	2.000	32159	G505BX104K
0050	100251	CAP C MOLD 1000PF 50V 20%	C4,16	2.000	71590	CW15C102M
0051	117631	CAP CER DP180PF 100V 5% COG .1LS<.1	C6	1.000	96733	DB44BY181J
0052	117624	CAP CER DP15PF 100V 5% COG .1LS <.1	C7	1.000	96733	DB44BY150J
0053	117570	CAP CER DP .01 UF 100V 20% X7R	C8,14,	24.000	04222	SR201C103MAA
0053	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	20-22,	.000		
0053	99REF02	************ REF DESN'TORS CONT *************	25-27,	.000		
0053	99REF03	************ REF DESN'TORS CONT *************	29-44	.000		
0056	106429	CAP METMYL.33UF 200V 5%	C11	1.000	14752	210B1C334J
0057	11963601	CAP CER DP.033UF 50V 10% 30PPM/C	C13	1.000	96733	DG46BY333K
0058	100372	CAP C MOLD3300PF 100V 10% NPO 30PPM	C15	1.000	26654	2130C0G100R332K
0059	117636	CAP CER DP330PF 100V 5% COG .1LS<.2	C17	1.000	96733	DB45BY331J
0060	103495	CAP TANT 2.2UF 25V 10% .18D*.38H*.	C18,23,	3.000	56289	196D225X9025HA1
0060	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	28	.000		
0061	101558	RES CC 1/4W 100K 5%	R3	1.000	01121	CB1045
0062	101536	RES CC 1/4W 330 OHMS 5%	R5	1.000	01121	CB3315

REPLACEABLE PARTS LIST — Continued

Title: AM Audio Synthesizer PC Board Assembly A5A, 07736703 (Figure 5-20) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0064	101896	RES MF 3.01K .12W 1% 100PPM	R6,7	2.000	19701	MF5C-D-3011-F
0066	101672	RES CC 1/4W 51 OHMS 5%	R8	1.000	01121	CB5105
0068	119013	RES MF 5.62K .1W 1% 25PPM/C <.14	R9	1.000	91637	CMF-55 T9
0070	117859	RES MF 402 .1W 1% 100PPM <.28L*	R10	1.000		C=RN55D4020F
0072	620259	RES MF 768 .13W 1% 100PPM	R11	1.000		C=RN60D7680F
0074	106213	RES MF 1.10K .12W 1% 100PM	R12	1.000	16299	NA60
0076	102097	RES MF 1.00K .12W 1% 100PPM	R13	1.000	19701	MF5C-D-1001 F
0078	102879	JUMPER, 22AWG INSULATED .09D .25L	R18,W6,7	3.000	55210	L-2007-1
0079	101598	RES CC 1/4W 4.7K 5%	R19	1.000	01121	CB4725
0080	101544	RES CC 1/4W 6.8K 5%	R20	1.000	01121	CB6825
0081	101601	RES CC 1/4W 3.9K 5%	R21,22	2.000	01121	CB3925
0082	101570	RES CC 1/4W 10K 5%	R23	1.000	01121	CB1035
0083	045008	RES MODULE4-12K .1W 20% COMP CARBON	RN2	1.000	52542	MRG-C-5Y-12K-K
0084	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L1	1.000	02114	VK200-20/4B
0085	106675	INDUCT FXD22UH 50QMIN .155X.375	L2	1.000	99800	1537-724
0086	119321	CON SHRTNGSKTS .032D@.1	W1	1.000	63058	MSB3604-100-SN200
0087	100565	CON PC PINSINGLE MALE POST 10/INCH	TP1,2,W1	4.000	00779	86090-4
0089	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1,2	2.000	98291	51-053-0000
0093	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0095	08326251	FAB MODULE TOP A5A		1.000	52542	
0096	10063207	PHMS CRES 6-32 X 7/16		3.000	96906	MS51957-29
0097	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: FM Audio Synthesizer PC Board Assembly A5B, 07736704 (Figure 5-21)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	7077367TAB	SCH PCB AUDIO SYNTH	REF	.000	52542	
0002	607736701	BLOCK DIAGRAM AUDIO SYNTHESIZER A4	REF	.000	52542	
0003	2077367	A/W PCB AUDIO SYNTHESIZER AM	REF	.000	52542	
0004	077367	FAB PCB AUDIO SYNTHESIZER AM		1.000	52542	
0007	103974	IC TTL MSI74LS85 4BIT MAGTD CMPR	U1	1.000	01295	SN74LS85N
0008	116322	IC TTL MSI74LS138 3-8LINE DECODER	U2	1.000	27014	DM74LS138N
0009	117955	IC TTL MSI74LS245 8 3ST XCUR ^INV	U3	1.000	01295	SN74LS245
0011	103749	IC TTL SSI74LS04 HEX INV <20NS	U5	1.000	01295	SN74LS04N
0012	117508	IC TTL MSI74LS244 8BFR 2ENBL LINEDR	U6	1.000	01295	SN74LS244N
0013	116556	IC TTL MSI74LS374 8 D EDG-TRG F/F	U7-10	4.000	01295	SN74LS374N
0016	117514	IC TTL SSI74LS38 QUAD 2IN OPN COL B	U12	1.000	01295	SN74LS38N
0017	045207	IC TTL MSI74167 DECADE RATE MULT	U13-16	4.000	01295	SN74167N
0018	045296	IC TTL SSI7425 DUAL 4IN NOR W/STROB	U17	1.000	01295	SN7425N
0019	103164	IC TTL MSI74LS196 PRST BCD CNTR 2,5	U18	1.000	01295	SN74LS196N
0020	116526	IC TTL 74LS490 DUAL DEC CNTR >40MHZ SET9&CLR0	U19	1.000	01295	SN74LS490AN
0021	116162	IC TTL MSI74LS151 8BIT DATA SEL	U20	1.000	01295	SN74LS151N
0022	117871	IC TTL MSI74LS160 SYN,PRESET, DCLR	U21,22	2.000	01295	SN74LS160AN
0023	08315401	ASSY PROM PROGRAMED	U23	1.000	52542	
0024	123029	DAC IC DAC0800LCN 8 BIT COMP CUREENT OUTPUTS	U24	1.000	27014	DAC0800LCN
0025	123393	IC OP AMP TL071 JFET LOW NOISE 10UV/C	U25,28	2.000	01295	TL071CP
0026	118743	IC CMOS 14051 8-1 ANALOG MULTIPLE	U26	1.000	04713	MC14051BCP
0027	123037	DAC IC AD7533KN 10BIT MULTI 0.1% LIN (1LSB)	U27	1.000	24335	AD7533KN
0029	117013	IC VOLTREG78L12 12.5/11.5V .07A 92	U29	1.000	04713	MC78L12ACP
0030	117555	IC VOLTREG79L12 -12.5/11.5 40MA TO9	U30	1.000	04713	MC79L12ACP
0038	117349	XSTR SIPNPMPS-A63 30V H>5K@10MA	Q2	1.000	04713	MPS-A63
0040	100385	DIODE SGN1N4151 50V	CR1,4	2.000	03508	1N4151
0042	100377	DIODE REF 6.2V .01%/C 1N821	VR1	1.000	04713	1N821
0045	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C2,5,9,	8.000	56289	2C37Z5U105M050B
0045	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	10,19,24	.000		
0045	99REF02	************ REF DESN'TORS CONT *************	45,46	.000		
0049	100155	CAP C MOLD .1 UF 50V 10%	C3,12	2.000	32159	G505BX104K
0050	100251	CAP C MOLD 1000PF 50V 20%	C4,16	2.000	71590	CW15C102M
0051	117631	CAP CER DP180PF 100V 5% COG .1LS<.1	C6	1.000	96733	DB44BY181J
0052	117624	CAP CER DP15PF 100V 5% COG .1LS <.1	C7	1.000	96733	DB44BY150J
0053	117570	CAP CER DP .01 UF 100V 20% X7R	C8,14,	24.000	04222	SR201C103MAA
0053	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C20-22	.000		
0053	99REF02	************ REF DESN'TORS CONT *************	C25-27,	.000		
0053	99REF03	************ REF DESN'TORS CONT *************	C29-44	.000		
0056	106429	CAP METMYL.33UF 200V 5%	C11	1.000	14752	210B1C334J
0057	11963601	CAP CER DP.033UF 50V 10% 30PPM/C	C13	1.000	96733	DG46BY333K
0058	100372	CAP C MOLD3300PF 100V 10% NPO 30PPM	C15	1.000	26654	2130C0G100R332K
0059	117636	CAP CER DP330PF 100V 5% COG .1LS<.2	C17	1.000	96733	DB45BY331J
0060	103495	CAP TANT 2.2UF 25V 10% .18D*.38H*.	C18,23,	3.000	56289	196D225X9025HA1
0060	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	28	.000		
0061	101558	RES CC 1/4W 100K 5%	R3	1.000	01121	CB1045
0062	101536	RES CC 1/4W 330 OHMS 5%	R5	2.000	01121	CB3315

REPLACEABLE PARTS LIST — Continued

Title: FM Audio Synthesizer PC Board Assembly A5B, 07736704 (Figure 5-21) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0064	101896	RES MF 3.01K .12W 1% 100PPM	R6,7	2.000	19701	MF5C-D-3011-F
0066	101672	RES CC 1/4W 51 OHMS 5%	R8	1.000	01121	CB5105
0068	119013	RES MF 5.62K .1W 1% 25PPM/C <.14	R9	1.000	91637	CMF-55 T9
0070	117859	RES MF 402 .1W 1% 100PPM <.28L*	R10	1.000		C=RN55D4020F
0072	620259	RES MF 768 .13W 1% 100PPM	R11	1.000		C=RN60D7680F
0074	106213	RES MF 1.10K .12W 1% 100PM	R12	1.000	16299	NA60
0076	102097	RES MF 1.00K .12W 1% 100PPM	R13	1.000	19701	MF5C-D-1001 F
0078	102879	JUMPER, 22AWG INSULATED .09D .25L	R18,W6,	3.000	55210	L-2007-1
0078	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	W8	.000		
0079	101598	RES CC 1/4W 4.7K 5%	R19	1.000	01121	CB4725
0080	101544	RES CC 1/4W 6.8K 5%	R20	1.000	01121	CB6825
0081	101601	RES CC 1/4W 3.9K 5%	R21,22	2.000	01121	CB3925
0082	101570	RES CC 1/4W 10K 5%	R23	1.000	01121	CB1035
0083	045008	RES MODULE4-12K .1W 20% COMP CARBON	RN2	1.000	52542	MRG-C-5Y-12K-K
0084	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L1	1.000	02114	VK200-20/4B
0085	106675	INDUCT FXD22UH 50QMIN .155X.375	L2	1.000	99800	1537-724
0087	100565	CON PC PINSINGLE MALE POST 10/INCH	TP1,2	2.000	00779	86090-4
0089	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1,2	2.000	98291	51-053-0000
0093	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0095	08326252	FAB MODULE TOP A5B		1.000	52542	
0096	10063207	PHMS CRES 6-32 X 7/16		3.000	96906	MS51957-29
0097	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Downconverter PC Board Assembly A6, 07734301 (Figure 5-24)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707734301	SCHEM PCB DOWNCONVERTER	REF	.000	52542	
0002	2077343	ARTWORK PCB DOWNCONVERTER	REF	.000	52542	
0003	607734301	BLOCK DIAGRAM DOWNCONVERTER A6	REF	.000	52542	
0007	077343	FAB PCB DOWNCONVERTER		1.000	52542	
0009	117627	CAP CER DP82PF 100V 5% COG .1LS <.1	C1,11	2.000	96733	DB44BY820J
0010	117626	CAP CER DP68PF 100V 5% COG .1LS <.1	C2,10	2.000	96733	DB44BY680J
0011	117568	CAP CER DP1000PF 100V 10% X7R .15SQ	C3,6,9	17.000	04222	3418100C102K
0011	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	18,23,29	.000		
0011	99REF02	************ REF DESN'TORS CONT *************	34,59,67	.000		
0011	99REF03	************ REF DESN'TORS CONT *************	85,92,	.000		
0011	99REF04	************ REF DESN'TORS CONT *************	105-110	.000		
0014	117471	CAP CER DP33PF 100V 5% COG .1LS<.15	C4,5,7,8	7.000	96733	DB44BY330J
0014	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	26,60,66	.000		
0017	117570	CAP CER DP .01 UF 100V 20% X7R	C12,25,	8.000	04222	SR201C103MAA
0017	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	33,65,88	.000		
0017	99REF02	************ REF DESN'TORS CONT *************	89,90,98	.000		
0018	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C13-15	4.000		TAPB22M25
0018	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	79	.000		
0019	100155	CAP C MOLD .1 UF 50V 10%	C16,17	15.000	32159	G505BX104K
0019	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	19,27,54	.000		
0019	99REF02	************ REF DESN'TORS CONT *************	75,77,81	.000		
0019	99REF03	************ REF DESN'TORS CONT *************	83,84,99	.000		
0019	99REF04	************ REF DESN'TORS CONT *************	100	.000		
0019	99REF05	************ REF DESN'TORS CONT *************	111-113	.000		
0020	117628	CAP CER DP100PF 100V 5% COG .1LS<.1	C20,21	7.000	96733	DB44BY101J
0020	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	24,55,62	.000		
0020	99REF02	************ REF DESN'TORS CONT *************	91,93	.000		
0021	117636	CAP CER DP330PF 100V 5% COG .1LS<.2	C22,32,	4.000	96733	DB45BY331J
0021	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	51,58	.000		
0023	116619	CAP C DP .047UF 10%/.056UF 20% 100V X7R .1LS	C30,31	4.000	51642	200-100-X7R563M
0023	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	37,53	.000		
0029	103291	CAP CER DP820PF 50V 5% COG .2LS <.25SQ	C38	1.000	96733	DG445BY71J
0030	117641	CAP CER DP22PF 100V 5% COG .1LS <.1	C39,114,	3.000	96733	DB44BY220J
0030	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	119	.000		
0031	100372	CAP C MOLD3300PF 100V 10% NPO 30PPM	C40	1.000	26654	2130C0G100R332K
0032	11979801	CAP CER DP .033UF 50V 10% X7R .2SQ .1LS	C41	1.000	71590	CW20C333K
0033	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C42,47,	4.000	96733	DB44BY100J
0033	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	116,118	.000		
0035	103935	CAP VARCER1-5PF 100V -.035%/C <.2D	C57,82	2.000	72982	513-012A1-5
0038	117620	CAP CER DP2PF 100V .5PF COG	C50	1.000	96733	DB44BY2R0D
0040	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C63,78	2.000	56289	2C37Z5U105M050B
0044	117935	CAP CER DP18PF 100V 5% COG .1LS	C69,72	2.000	96733	DB45BY180J
0045	99REF50	******* REF DESN'TORS NOT USED **************	C104	.000		
0046	117640	CAP CER DP 27PF 100V 5% COG .1LS <.15	C70,71	2.000	96733	DB44BY270J
0047	117625	CAP CER DP56PF 100V 5% COG .1LS <.1	C73	1.000	96733	DB44BY560J
0048	117359	CAP CER DP47PF 100V 5% COG .1LS<.15	C76,80	6.000	96733	DB44BY470J

REPLACEABLE PARTS LIST — Continued

Title: Downconverter PC Board Assembly A6, 07734301 (Figure 5-24) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0048	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	86,	.000		
0048	99REF02	************ REF DESN'TORS CONT *************	101-103	.000		
0049	117358	CAP CER DP4.7PF 100V COG <.15W	C96,97,	2.000	71590	CN10A4R7D
0051	117623	CAP CER DP12PF 100V 5% COG .1LS <.1	C115	1.000	96733	DB44BY120J
0052	117624	CAP CER DP15PF 100V 5% COG .1LS <.1	C117	1.000	96733	DB44BY150J
0053	102703	DIODE SIG FDH300 LKG<1NA@125V VF=1V@0.1A	CR1	1.000	13715	FDH300
0055	11990901	DIODE VCAP 6.8PF@4V 10% 2.7<TR<3.1@2-30V DO-7	CR2	1.000	04713	IN5461A
0057	100385	DIODE SGN1N4151 50V	CR9	1.000	03508	1N4151
0062	101260	RECEPT RF SUBMIN MALE PC MT SNAP-ON	J5	1.000	98291	51-051-0000
0064	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1,3,4	3.000	98291	51-053-0000
0067	101322	INDUCT FXD.06UH 10% 40QMIN .10X.25	L1,4,19	3.000	06560	10150-2
0069	101319	INDUCT FXD.15UH 20% 42QMIN .12X.33	L2,3	2.000	00213	WEE-WEE-0.15
0070	101312	INDUCT FXD1.0UH 10% 50QMIN .16X.38	L5	1.000	99800	1537-12
0071	101311	INDUCT FXD.15UH 10% 38QMIN .10X.25	L6,9	2.000	00213	DD-0.15
0074	101323	INDUCT FXD.05UH 10% .10X.25	L13-15	4.000	06560	10150-17K
0074	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	20	.000		
0076	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L16	1.000	02114	VK200-20/4B
0077	103006	INDUCT FXD.22UH 20% QGT42 FGT414MHZ	L17	1.000	78526	DKM -.22
0078	101318	INDUCT FXD.47UH 20% 41QMIN .12X.33	L18	1.000	00213	WEE-WEE-0.47
0080	103171	XSTR SINPN2N6304 15V 25B250@2MA 1.4	Q1,2	2.000	04713	2N6304
0081	101378	XSTR SI PNP 2N3906 40V 100B300@10MA TO-92	Q3,5,9	3.000	04713	2N3906
0082	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q4,6	2.000	04713	2N3904
0083	103948	XSTR SI NPN BFR90 15V 25B50 @ 14 MA 5GHZ RF	Q7	1.000	04713	BFR90
0084	103129	XSTR SINPNBFR94 25V BGT40@.15A FT3.	Q11	1.000	25403	BFR94
0085	112097	XSTR SIPNP MJE700 60V 4A B>750@1.5A TO-205AA	Q12,14	2.000	04713	MJE700
0086	106617	XSTR SINPNMJE800 60V B>750@1.5A C77	Q13	1.000	04713	MJE800
0089	101719	RES CC 1/8W 2.2K 5%	R1,6	2.000	01121	BB2225
0090	101720	RES CC 1/8W 180 OHMS 5%	R2-5	4.000	0112	BB1815
0091	101625	RES CC 1/4W 470 OHMS 5%	R7,8,67	3.000	01121	CB4715
0092	101569	RES CC 1/4W 1.0K 5%	R9	1.000	01121	CB1025
0093	101740	RES CC 1/8W 6.2K 5%	R10,11	3.000	01121	BB6225
0093	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	17	.000		
0094	101707	RES CC 1/8W 47 OHMS 5%	R12	1.000	01121	BB4705
0096	101710	RES CC 1/8W 560 OHMS 5%	R13-15	3.000	01121	BB5615
0097	101797	RES CC 1/8W 22K 5%	R16	1.000	01121	BB2235
0099	101976	RES CC 1/8W 100K 5%	R18	1.000	01121	BB1045
0101	101697	RES CC 1/8W 10K 5%	R19,27,	6.000	01121	BB1035
0101	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	40,41,52	.000		
0101	99REF02	************ REF DESN'TORS CONT *************	53	.000		
0103	101711	RES CC 1/8W 1.0K 5%	R20,26	2.000	01121	BB1025
0104	103088	RES MF 1.07K 1% .13W@125C,25PPM	R21	1.000	91637	MFF 1/8 T9
0105	102525	RES MF 100K .1 W 1% 50PPM	R22	1.000		RN55C1003F
0106	119949	RES MF 953 .1W 1% 50PPM <.14D*.28L	R23	1.000		RN55C9530F
0107	117596	RES MF 51.1 .1 W 1% 100PPM <.28L	R24,38	2.000		C=RN55D51R1F
0109	119092	RES MF 30.1K .1W 1% 25PPM/C <.14	R25	1.000	91637	CMF-55 T9
0112	101476	RES CC 1/2W 390 OHMS 5%	R28,31	2.000	01121	EB3915

REPLACEABLE PARTS LIST — Continued

Title: Downconverter PC Board Assembly A6, 07734301 (Figure 5-24) – Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0114	101609	RES CC 1/4W 100 OHMS 5%	R30,68	2.000	01121	CB1015
0115	101807	RES CC 1/8W 18 OHMS 5%	R32-34	3.000	01121	BB1805
0116	117588	RES MF 33.2 .1 W 1% 100PPM <.28L	R36	1.000		C=RN55D33R2F
0117	102228	RES MF 442 .12W 1% 100PPM	R37	1.000	91637	MFF-1/8 T1
0119	118988	RES MF 3.24K .1W 1% 25PPM/C <.14	R42	1.000	91637	CMF-55 T9
0120	117811	RES MF 2.00K .1W 1% 100PPM	R44	1.000		C=RN55D2001F
0121	101583	RES CC 1/4W 560 OHMS 5%	R45	1.000	01121	CB5615
0124	101800	RES CC 1/8W 82 OHMS 5%	R47,48	2.000	01121	BB8205
0131	101508	RES CC 1/2W 120 OHMS 5%	R61,62	3.000	0112	EB1215
0131	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	76	.000		
0134	112284	RES CC 1/4W 1.0 OHMS 10%	R63-65	3.000		WC025K
0135	101509	RES CC 1/2W 27 OHMS 5%	R66	1.000	01121	EB2705
0138	101542	RES CC 1/4W 270 OHMS 5%	R72	1.000	01121	CB2715
0140	11974701	RES MF 5.11 OHM .1W 1% 100PPM/C RN55	R73,78	2.000	91637	CMF-55 T1
0142	101557	RES CC 1/4W 10 OHMS 5%	R75	1.000	01121	CB1005
0143	99REF50	******* REF DESN'TORS NOT USED **************	R77,80	.000		
0144	101542	RES CC 1/4W 270 OHMS 5%	R79	1.000	01121	CB2715
0145	101701	RES CC 1/8W 100 OHMS 5%	R81	1.000	01121	BB1015
0147	100541	TEST POINTRED PC MT RIGHT ANGLE	TP1	1.000	74970	105-0852-001
0149	102911	MIX DBLBAL1-600MHZ 5.5DBLOSS 40DBIS	U1	1.000	15542	SAM-1
0150	025765	IC ECL 1670 D TYPE FLIP FLOP	U2	1.000	04713	MC1670L
0151	025792	IC LIN MSCLM311 COMPARATOR DIFF V	U3	1.000	27014	LM311H
0152	11993501	IC ECL MSICA3199 1/4@1.0GHZ	U4	1.000	02735	CA3199E
0153	118742	IC OP AMP A88DB IB1.5UA <7NV/(HZ)E.5 10MHZ	U5	1.000	18324	NE5534AN
0154	116929	AMP HYBRID MWA120 0-400MHZ A14DB P>8.2DBM TO5	U6,7	4.000	04713	MWA120
0154	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	U12,13	.000		
0156	10281501	MIX BAL 1-1000MHZ 6DBLOSS 40DBISO HI LEVEL	U8	1.000	15542	SAM-2H
0157	116930	AMP HYBRID MWA130 0-400MHZ A14DB P>18DBM TO5	U14	1.000	04713	MWA130
0160	100565	CON PC PINSINGLE MALE POST 10/INCH	(W1)	2.000	00779	86090-4
0161	119321	CON SHRTNGSKTS .032D@.1	W1	1.000	63058	MSB3604-100-SN200
0162	102879	JUMPER, 22AWG INSULATED .09D .25L	W2	1.000	55210	L-2007-1
0163	118004	NYLON WSHRFLAT .093ID,.187OD,.031THK	(Q11)	4.000	86928	5610-9-31
0164	100708	NUT HEX 8-32 .31AF .13THK SS	(Q11)	1.000	80205	NAS671C8
0165	100487	LUG SOLDER#8INT TOOTH.88L 1HOLE.093	(Q11)	1.000	79963	501-.169
0166	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0167	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0168	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0172	08326106	FAB MODULE TOP A6		1.000	52542	
0175	07738501	FAB SHIELD COMP SIDE IRID & S/SCR		1.000	52542	
0176	07739701	FAB SHIELD CKT SIDE IRID		1.000	52542	
0177	10062512	PHMS CRES 2-56 X 3/4		25.000	96906	MS51957-9
0178	100661	SPLIT LOCK#2 CRES		25.000	96906	MS35337-77

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Loop 1 Output PC Board Assembly A7, 07752101 (Figure 5-27)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0002	707752101	SCHEM PCB LOOP 1	REF	.000	52542	
0003	607752101	BLOCK DIAGRAM LOOP 1	REF	.000	52542	
0004	2077521	ARTWORK PCB LOOP 1	REF	.000	52542	
0006	077521	FAB PCB LOOP 1		1.000	52542	
0010	117570	CAP CER DP .01 UF 100V 20% X7R	C1,6,7,	8.000	04222	SR201C103MAA
0010	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	81,88,	.000		
0010	99REF02	************ REF DESN'TORS CONT **************	100,108	.000		
0010	99REF03	************ REF DESN'TORS CONT **************	134	.000		
0011	100155	CAP C MOLD .1 UF 50V 10%	C25,28,	10.000	32159	G505BX104K
0011	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	76,77,84	.000		
0011	99REF02	************ REF DESN'TORS CONT **************	85,87,92	.000		
0011	99REF03	************ REF DESN'TORS CONT **************	116,123	.000		
0012	117568	CAP CER DP1000PF 100V 10% X7R .15SQ	C2,3,12,	38.000	04222	3418100C102K
0012	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	13,34-36	.000		
0012	99REF02	************ REF DESN'TORS CONT **************	38,42,48	.000		
0012	99REF03	************ REF DESN'TORS CONT **************	52,62,65	.000		
0012	99REF04	************ REF DESN'TORS CONT **************	72,79,94	.000		
0012	99REF05	************ REF DESN'TORS CONT **************	95,97,99	.000		
0012	99REF06	************ REF DESN'TORS CONT **************	102-105	.000		
0012	99REF07	************ REF DESN'TORS CONT **************	112-115	.000		
0012	99REF08	************ REF DESN'TORS CONT **************	122,124-	.000		
0012	99REF09	************ REF DESN'TORS CONT **************	126,129,	.000		
0012	99REF10	************ REF DESN'TORS CONT **************	131-133	.000		
0012	99REF11	************ REF DESN'TORS CONT **************	136,142,	.000		
0012	99REF12	************ REF DESN'TORS CONT **************	143	.000		
0014	117629	CAP CER DP120PF 100V 5% COG .1LS<.1	C15	1.000	96733	DB44BY121J
0016	117358	CAP CER DP4.7PF 100V COG <.15W	C16	1.000	71590	CN10A4R7D
0017	117675	CAP CER DP390PF 100V 5% COG .1LS<.2	C17,56,	3.000	96733	DB45BY391J
0017	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	68	.000		
0018	117638	CAP CER DP680PF 100V 5% COG .1LS<.2	C18,19	2.000	96733	DB45BY681J
0020	10329101	CAP CER DP820PF 100V 5% COG .1LS <.25SQ	C20	1.000	96733	DB045BY821J
0022	106515	CAP TANT 6.8UF 35V 20% .25LS .23D	C24,82	5.000	56289	196D685X0035KE3
0022	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	101,127	.000		
0022	99REF02	************ REF DESN'TORS CONT **************	128	.000		
0024	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C29,117,	3.000	56289	2C37Z5U105M050B
0024	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	121	.000		
0026	117631	CAP CER DP180PF 100V 5% COG .1LS<.1	C32	1.000	96733	DB44BY181J
0027	117620	CAP CER DP2PF 100V .5PF COG	C39,41	2.000	96733	DB44BY2ROD
0029	117628	CAP CER DP100PF 100V 5% COG .1LS<.1	C33,37,	6.000	96733	DB44BY101J
0029	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	49,53,61	.000		
0029	99REF02	************ REF DESN'TORS CONT **************	64	.000		
0031	117623	CAP CER DP12PF 100V 5% COG .1LS <.1	C46	1.000	96733	DB44BY120J
0033	103185	CAP C CHIP10PF 5%>50V30PPM.11LX.065	C47	1.000	96773	SG133BY100JP
0035	100315	CAP C CHIP47PF 100V5%.100LX.065WNPO	C50	1.000	96773	SB133BY470JP
0037	117630	CAP CER DP150PF 100V 5% COG .1LS<.1	C51,54,	4.000	96733	DB44BY151J
0037	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	63,66	.000		

REPLACEABLE PARTS LIST — Continued

Title: Loop 1 Output PC Board Assembly A7, 07752101 (Figure 5-27) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0039	103935	CAP VARCER1-5PF 100V -.035%/C <.2D	C60	1.000	72982	513-012A1-5
0041	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C75,83	4.000		TAPB22M25
0041	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	86,91	.000		
0042	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C130	1.000	96733	DB44BY100J
0043	117359	CAP CER DP47PF 100V 5% COG .1LS<.15	C107,135	2.000	96733	DB44BY470J
0044	117633	CAP CER DP220PF 100V 5% COG .1LS<.1	C137-141	5.000	96733	DB44BY221J
0045	101629	RES CC 1/4W 82 OHMS 5%	R1	1.000	01121	CB8205
0047	101536	RES CC 1/4W 330 OHMS 5%	R6,22	2.000	01121	CB3315
0049	101690	RES CC 1/4W 68 OHMS 5%	R10	1.000	01121	CB6805
0051	101566	RES CC 1/4W 220 OHMS 5%	R11,141	2.000	01121	CB2215
0053	118959	RES MF 1.69K .1W 1% 25PPM/C <.14	R16,17	2.000	91637	CMF-55 T9
0055	102090	RES MF 49.9 .1 W 1% 25PPM	R18	1.000	19701	MF4C-E-49R9 F
0057	101672	RES CC 1/4W 51 OHMS 5%	R19,110,	5.000	01121	CB5105
0057	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	118,119	.000		
0057	99REF02	************ REF DESN'TORS CONT *************	139	.000		
0059	101570	RES CC 1/4W 10K 5%	R20,23,	9.000	01121	CB1035
0059	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	25,26,31	.000		
0059	99REF02	************ REF DESN'TORS CONT *************	32,126,	.000		
0059	99REF03	************ REF DESN'TORS CONT *************	127,132	.000		
0061	101607	RES CC 1/4W 20K 5%	R21	1.000	01121	CB2035
0065	101565	RES CC 1/4W 12K 5%	R24	1.000	01121	CB1235
0069	101569	RES CC 1/4W 1.0K 5%	R29,84	3.000	01121	CB1025
0069	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	105	.000		
0071	101609	RES CC 1/4W 100 OHMS 5%	R30,93,	3.000	01121	CB1015
0071	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	96	.000		
0073	101615	RES CC 1/4W 150 OHMS 5%	R33,34,	4.000	01121	CB1515
0073	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	135,136	.000		
0075	101557	RES CC 1/4W 10 OHMS 5%	R35	1.000	01121	CB1005
0077	101711	RES CC 1/8W 1.0K 5%	R38,109	2.000	01121	BB1025
0079	101715	RES CC 1/8W 5.6K 5%	R39,40	2.000	01121	BB5625
0081	101720	RES CC 1/8W 180 OHMS 5%	R41	1.000	0112	BB1815
0083	101974	RES CC 1/8W 1.5K 5%	R42	1.000	01121	BB1525
0085	101476	RES CC 1/2W 390 OHMS 5%	R46	1.000	01121	EB3915
0087	101774	RES CC 1/4W 430 OHMS 5%	R51,52,	5.000	01121	CB4315
0087	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	113,114,	.000		
0087	99REF02	************ REF DESN'TORS CONT *************	137	.000		
0089	102879	JUMPER, 22AWG INSULATED .09D .25L	R55,57	2.000	55210	L-2007-1
0091	117757	RES MF 1.00K .1W 1% 100PPM <.28	R56,58	2.000		C=RN55D1001F
0093	11465501	RES CC 1/8W 2.0K 5%	R59,75	2.000	81349	RCR056202JS
0095	101707	RES CC 1/8W 47 OHMS 5%	R62	1.000	01121	BB4705
0097	101448	RES CC 1/2W 300 OHMS 5%	R63,80	2.000	01121	EB3015
0099	101719	RES CC 1/8W 2.2K 5%	R76	1.000	01121	BB2225
0101	101498	RES CC 1/2W 100 OHMS 5%	R79	1.000	01121	EB1015
0103	101625	RES CC 1/4W 470 OHMS 5%	R91,94	2.000	01121	CB4715
0105	101784	RES CC 1/4W 2.7 OHMS 5%	R92,95	3.000	01121	CB27G5
0105	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	104	.000		

Title: Loop 1 Output PC Board Assembly A7, 07752101 (Figure 5-27) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0107	101588	RES CC 1/4W 240 OHMS 5%	R97	1.000	01121	CB2415
0109	101552	RES CC 1/4W 15K 5%	R98,100	3.000	01121	CB1535
0109	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	102	.000		
0111	101574	RES CC 1/4W 47K 5%	R99,101,	3.000	01121	CB4735
0111	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	103	.000		
0112	101555	RES CC 1/4W 200 OHMS 5%	R106	1.000	01121	CB2015
0113	101913	RES CC 1/8W 3.0K 5%	R107	1.000	01121	BB3025
0114	101537	RES CC 1/4W 300 OHMS 5%	R115,117	2.000	01121	CB3015
0115	10167201	RES CC 1/4W 51 OHMS 5% .4LS	R139	1.000	01121	CB5105
0116	101834	RES CC 1/8W 10 OHMS 5%	R123,124	2.000	01121	BB1005
0117	101702	RES CC 1/8W 150 OHMS 5%	R125	1.000	01121	BB1515
0119	101727	RES CC 1/4W 18 OHMS 5%	R116	1.000	01121	CB1805
0120	101735	RES CC 1/4W 56 OHMS 5%	R128	1.000	0112	CB5605
0121	101541	RES CC 1/4W 5.1K 5%	R129,131	2.000	01121	CB5125
0123	101561	RES CC 1/4W 39K 5%	R130	1.000	01121	CB3935
0125	101592	RES CC 1/4W 390 OHMS 5%	R133	1.000	01121	CB3915
0126	101732	RES CC 1/4W 36 OHMS 5%	R134	1.000	01121	CB3605
0127	101668	RES CC 1/4W 180 OHMS 5%	R142	1.000	01121	CB1815
0131	101560	RES CC 1/4W 47 OHMS 5%	R140	1.000	01121	CB4705
0133	101690	RES CC 1/4W 68 OHMS 5%	R143,144	2.000	01121	CB6805
0135	103390	POT 18T PC 500 OHMS .5W 10% CERM TOPADJ	R145	1.000	73138	68WR500
0140	045277	IC ECL 12040 PHASE-FREQ DET	U2	1.000	04713	MC12040L
0142	118742	IC OP AMP A88DB IB1.5UA <7NV/(HZ)E.5 10MHZ	U3	1.000	18324	NE5534AN
0144	119975	IC OP AMP 5532 DUAL LOW NOISE	U5	1.000	18324	NE5532AN
0146	116929	AMP HYBRID MWA120 0-400MHZ A14DB P>8.2DBM TO5	U6	1.000	04713	MWA120
0148	123649	IC LIN AMP 1.8GHZ@1DBPT 12DB 10DBM@1DB UXPAC	U7,8	2.000	25539	MSA-0335-21
0149	123648	IC LIN AMP 1.7GHZ@1DBPT 12.5DB 4DBM@1DB UXPAC	U9,10,13	3.000	25539	MSA-0235-21
0150	123408	IC LIN MPQ6002 QUAD NPN XSTR 25V	U11	1.000	04713	MPQ6002
0151	117703	IC OP AMP TL072 2JFET A68DB 10UV/C	U12	1.000	01295	TL072CP
0154	101378	XSTR SI PNP 2N3906 40V 100B300@10MA TO-92	Q2,4	2.000	04713	2N3906
0156	119183	MOSFET NCHVN10KM 60V,<.5A,<2.5V@.5A	Q3,18	2.000	17856	VN10KM
0158	101367	XSTR SIPNPPN3645 60V 80B240@50MA FT	Q5	1.000	07263	PN3645-18
0160	103948	XSTR SI NPN BFR90 15V 25B50 @ 14 MA 5GHZ RF	Q6-8	3.000	04713	BFR90
0162	103335	XSTP SINPNBFR95 25V B>30@.15A FT3.5	Q9	1.000	25403	BFR95
0164	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q10-12	5.000	04713	2N3904
0164	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	16,17	.000		
0168	100440	DIODE SGNL1N4830 20V 2.69V FWD	CR3	1.000	03508	1N4830
0170	123529	DIODE VCAP KV3201 11PF@3V 5PF@10V DO-34 CASE	CR4,5,7	6.000	50101	KV3201
0170	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	8,10,11	.000		
0172	100447	DIODE PIN 47273 <.3PF@50V R<5@10MA	CR12-14	3.000	96067	MA47273
0174	100385	DIODE SGN1N4151 50V	CR18-23	6.000	03508	1N4151
0178	101312	INDUCT FXD1.0UH 10% 50QMIN .16X.38	L1	1.000	99800	1537-12
0180	101326	INDUCT FXD1.5UH 10% 38QMIN .12X.33	L2	1.000	00213	WEE-WEE-1.5
0182	123736	INDUCT FXD1.5UH 10% 38QMIN .12X.33	L5	1.000		
0183	083163	INDUCT FXD	L6	1.000	52542	
0184	101324	INDUCT FXD.33UH 10% 30QMIN .10X.25	L7,15,28	8.000	06560	4416-7K

REPLACEABLE PARTS LIST — Continued

Title: Loop 1 Output PC Board Assembly A7, 07752101 (Figure 5-27) -- Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0184	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	32-36	.000		
0186	106680	IND. FXD .22UH 10% PHENOL. CORE	L9	1.000	99800	1025-04
0188	106682	IND. FXD .10UH PHENOLIC CORE	L12,16	4.000	99800	1025-94
0188	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	17,31	.000		
0190	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L23,26	2.000	02114	VK200-20/4B
0192	103283	INDUCT FXD4.7UH 5%Q>44@7.9FR>70 <.1	L24,27	2.000	78526	SSD-4.7 5%
0196	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-5	5.000	98291	51-053-0000
0198	100575	TERM PRESSFDTH .086MTG .06MAT .515L	TP1-4,6,	8.000	98921	001-1007
0198	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	10-12	.000		
0199	100541	TEST POINTRED PC MT RIGHT ANGLE	TP5	1.000	74970	105-0852-001
0200	100565	CON PC PINSINGLE MALE POST 10/INCH		3.000	00779	86090-4
0202	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0204	119321	CON SHRTNGSKTS .032D@.1	W1	1.000	63058	MSB3604-100-SN200
0206	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0208	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0210	08326107	FAB MODULE TOP A7		1.000	52542	
0212	07756601	FAB SHIELD COMP SIDE IRID & S/SCR		1.000	52542	
0214	07756701	FAB SHIELD CKT SIDE IRID & S/SCR		1.000	52542	
0216	10062512	PHMS CRES 2-56 X 3/4		24.000	96906	MS51957-9
0217	100661	SPLIT LOCK#2 CRES		24.000	96906	MS35337-77

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Loop 1 IF PC Board Assembly A8, 07735301 (Figure 5-30)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707735301	SCHEM PCB LOOP 1 IF	REF	.000	52542	
0002	2077353	ARTWORK PCB LOOP 1 IF	REF	.000	52542	
0003	607735301	BLOCK DIAGRAM LOOP1 IF PCB	REF	.000	52542	
0007	077353	FAB PCB LOOP 1 IF		1.000	52542	
0010	117570	CAP CER DP .01 UF 100V 20% X7R	C1,6,7,	27.000	04222	SR201C103MAA
0010	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	12,15,22	.000		
0010	99REF02	************ REF DESN'TORS CONT *************	23,28,30	.000		
0010	99REF03	************ REF DESN'TORS CONT *************	38,46-55	.000		
0010	99REF04	************ REF DESN'TORS CONT *************	60,63,66	.000		
0010	99REF05	************ REF DESN'TORS CONT *************	67,70,	.000		
0010	99REF06	************ REF DESN'TORS CONT *************	81,82	.000		
0012	117359	CAP CER DP47PF 100V 5% COG .1LS<.15	C2,31,68	9.000	96733	DB44BY470J
0012	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	71-76	.000		
0016	117675	CAP CER DP390PF 100V 5% COG .1LS<.2	C4	1.000	96733	DB45BY391J
0018	117636	CAP CER DP330PF 100V 5% COG .1LS<.2	C5	1.000	96733	DB45BY331J
0020	117627	CAP CER DP82PF 100V 5% COG .1LS <.1	C8	1.000	96733	DB44BY820J
0022	117639	CAP CER DP 1000PF 5% 100V COG .1LS <.25Q	C9-11,20	16.000	96733	DB45BY102J
0022	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	32-35,	.000		
0022	99REF02	************ REF DESN'TORS CONT *************	41-45,78	.000		
0022	99REF03	************ REF DESN'TORS CONT *************	79,80	.000		
0024	117677	CAP CER DP560PF 100V 5% COG .1LS.2S	C14	1.000	96733	DB45BY561J
0026	117626	CAP CER DP68PF 100V 5% COG .1LS <.1	C16,21	3.000	96733	DB44BY680J
0026	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C29	.000		
0028	117628	CAP CER DP100PF 100V 5% COG .1LS<.1	C17,18,	3.000	96733	DB44BY101J
0028	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	25	.000		
0030	117780	CAP CER DP510PF 100V 5% COG .1LS<.2	C24	1.000	96733	DB45BY511J
0034	117641	CAP CER DP22PF 100V 5% COG .1LS <.1	C26,39	3.000	96733	DB44BY220J
0034	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C40	.000		
0036	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C27,36	3.000	56289	2C37Z5U105M050B
0036	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C37	.000		
0038	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C56,59	2.000		TAPB22M25
0040	100155	CAP C MOLD .1 UF 50V 10%	C57,58,	5.000	32159	G505BX104K
0040	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	62,64,65	.000		
0042	10371501	CAP TANT 10UF 20V 10% LONG LEADS	C61	1.000	56289	196D106X9020JA1
0044	117633	CAP CER DP220PF 100V 5% COG .1LS<.1	C3,13,	5.000	96733	DB44BY221J
0044	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	83-85	.000		
0046	117620	CAP CER DP2PF 100V .5PF COG	C69	1.000	96733	DB44BY2R0D
0050	101734	RES CC 1/4W 43 OHMS 5%	R1	1.000	01121	CB4305
0052	102879	JUMPER, 22AWG INSULATED .09D .25L	R24,40	2.000	55210	L-2007-1
0053	101729	RES CC 1/4W 27 OHMS 5%	R2,22	2.000	0112	CB2705
0054	101557	RES CC 1/4W 10 OHMS 5%	R25,	4.000	01121	CB1005
0054	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	26,31,45	.000		
0055	101584	RES CC 1/4W 5.6K 5%	R6,8	2.000	01121	CB5625
0057	101537	RES CC 1/4W 300 OHMS 5%	R4	1.000	01121	CB3015
0058	101669	RES CC 1/4W 680 OHMS 5%	R5	1.000	01121	CB6815
0059	101609	RES CC 1/4W 100 OHMS 5%	R9,27	2.000	01121	CB1015

REPLACEABLE PARTS LIST — Continued

Title: Loop 1 IF PC Board Assembly A8, 07735301 (Figure 5-30) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0060	101448	RES CC 1/2W 300 OHMS 5%	R12,34	2.000	01121	EB3015
0061	101574	RES CC 1/4W 47K 5%	R13,14	2.000	01121	CB4735
0062	101569	RES CC 1/4W 1.0K 5%	R17	1.000	01121	CB1025
0063	101577	RES CC 1/4W 1.5K 5%	R19	1.000	01121	CB1525
0064	101672	RES CC 1/4W 51 OHMS 5%	R21	1.000	01121	CB5105
0065	101560	RES CC 1/4W 47 OHMS 5%	R23	1.000	01121	CB4705
0066	101732	RES CC 1/4W 36 OHMS 5%	R28	1.000	01121	CB3605
0067	101552	RES CC 1/4W 15K 5%	R30	1.000	01121	CB1535
0068	101544	RES CC 1/4W 6.8K 5%	R32	1.000	01121	CB6825
0069	101690	RES CC 1/4W 68 OHMS 5%	R33	1.000	01121	CB6805
0073	99REF50	******* REF DESN'TORS NOT USED **************	R41	.000		
0084	101551	RES CC 1/2W 180 OHMS 5%	R35	1.000	01121	EB1815
0086	101553	RES CC 1/4W 2.0K 5%	R36	1.000	01121	CB2025
0088	101570	RES CC 1/4W 10K 5%	R37	3.000	01121	CB1035
0088	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R38,47	.000		
0090	101598	RES CC 1/4W 4.7K 5%	R39	1.000	01121	CB4725
0092	101728	RES CC 1/4W 24 OHMS 5%	R11	1.000	01121	CB2405
0093	101581	RES CC 1/4W 1.2K 5%	R15,49	2.000	01121	CB1225
0094	101508	RES CC 1/2W 120 OHMS 5%	R16	1.000	0112	EB1215
0095	101592	RES CC 1/4W 390 OHMS 5%	R18	1.000	01121	CB3915
0099	101668	RES CC 1/4W 180 OHMS 5%	R48	1.000	01121	CB1815
0101	112284	RES CC 1/4W 1.0 OHMS 10%	R50	1.000		WC025K
0102	101566	RES CC 1/4W 220 OHMS 5%	R3,7,10,	4.000	01121	CB2215
0102	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R44	.000		
0110	119981	RES MODULE 8@10K 2% .25W/R@70C 16DIP	RN1	1.000	80294	4116R-001-103
0112	410048	RES MODULE 9-10K 2% .2W/R@75C 10SIP	RN2	1.000	80294	4310R-101-103
0120	100447	DIODE PIN 47273 <.3PF@50V R<5@10MA	CR1-3,5	4.000	96067	MA47273
0124	100385	DIODE SGN1N4151 50V	CR7,9	2.000	03508	1N4151
0130	101324	INDUCT FXD.33UH 10% 30QMIN .10X.25	L1,5,8,	9.000	06560	4416-7K
0130	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	10,11,16	.000		
0130	99REF02	************* REF DESN'TORS CONT *************	17,18,19	.000		
0132	12316808	INDUCT ADJ 3 3/4 TURNS	L2	1.000	52542	
0133	12316807	INDUCT ADJ 4 3/4 TURNS	L7	1.000	52542	
0134	106688	IND FXD .56UH PHENOLIC CORE	L6	1.000	99800	1025-14
0135	101318	INDUCT FXD.47UH 20% 41QMIN .12X.33	L3	1.000	00213	WEE-WEE-0.47
0136	119988	INDUCT FXD .18UH 10% Q>35 .10X.25	L4	1.000	00213	DD-0.18
0144	101300	INDUCT FXD6.8UH 10% 40QMIN .16X.45	L12	1.000	00213	WEE-6.8
0146	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L13,15	2.000	02114	VK200-20/4B
0148	101299	INDUCT FXD2.7UH 10% 41QMIN .16X.45	L14	1.000	00213	WEE-2.7
0160	102696	XSTR SINPNPN3563 12V 20B200@8MA FT>	Q1,2	2.000	07263	PN3563-18
0162	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q5,6,10	3.000	04713	2N3904
0164	101378	XSTR SI PNP 2N3906 40V 100B300@10MA TO-92	Q7-9,11	5.000	04713	2N3906
0164	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	Q12	.000		
0166	99REF50	******* REF DESN'TORS NOT USED **************	Q13	.000		
0170	116930	AMP HYBRID MWA130 0-400MHZ A14DB P>18DBM TO5	U1	1.000	04713	MWA130
0171	10281501	MIX BAL 1-1000MHZ 6DBLOSS 40DBISO HI LEVEL	U2	1.000	15542	SAM-2H

REPLACEABLE PARTS LIST — Continued

Title: Loop 1 IF PC Board Assembly A8, 07735301 (Figure 5-30) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0172	123107	MIX BAL 5-1500MHZ 6.5DBLOSS 40DBISO	U6	1.000	15542	SAM-5
0174	123648	IC LIN AMP 1.7GHZ@1DBPT 12.5DB 4DBM@1DB UXPAC	U3,9	2.000	25539	MSA-0235-21
0176	123036	IC CMOS IH5049 DUAL DPST 35R	U4	1.000	32293	IH5049CJE
0178	123106	FREQ DBLR SK-2 1-1000MHZ <16.5DB LOSS	U5	1.000	15542	SK-2
0180	116590	IC OP AMP TL074 4JFET A68DB 10UV/C	U7	1.000	01295	TL074CN
0182	123037	DAC IC AD7533KN 10BIT MULTI 0.1% LIN (1LSB)	U10,11	2.000	24335	AD7533KN
0183	123650	IC LIN AMP 2.0GHZ@1DBPT 8.5DB 13DBM@1DB UXPAC	U8	1.000	25539	MSA-0435
0184	103749	IC TTL SSI74LS04 HEX INV <20NS	U12	1.000	01295	SN74LS04N
0186	117508	IC TTL MSI74LS244 8BFR 2ENBL LINEDR	U13,14	2.000	01295	SN74LS244N
0188	116556	IC TTL MSI74LS374 8 D EDG-TRG F/F	U15-17	5.000	01295	SN74LS374N
0188	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	U20,21	.000		
0190	118868	IC VOLTREF +10.00V +-5MV 5PPM/C TO-5 PKG	U18	1.000	24335	AD581LH
0192	117558	IC LIN MSC MC1413 DRIVER 7*50V/.5A NPN DARLIN	U19	1.000	04713	MC1413P
0194	103974	IC TTL MSI74LS85 4BIT MAGTD CMPR	U22	1.000	01295	SN74LS85N
0195	116928	AMP HYBRID MWA110 0-400MHZ A14DB P-2.5DBM TO5	U26	1.000	04713	MWA110
0196	116322	IC TTL MSI74LS138 3-8LINE DECODER	U23	1.000	27014	DM74LS138N
0198	117955	IC TTL MSI74LS245 8 3ST XCUR ^INV	U24	1.000	01295	SN74LS245
0199	123408	IC LIN MPQ6002 QUAD NPN XSTR 25V	U25	1.000	04713	MPQ6002
0200	100565	CON PC PINSINGLE MALE POST 10/INCH	TP4,5	2.000	00779	86090-4
0201	100541	TEST POINTRED PC MT RIGHT ANGLE	TP1-2	2.000	74970	105-0852-001
0202	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-6	6.000	98291	51-053-0000
0204	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0206	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0208	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0210	08326108	FAB MODULE TOP A8		1.000	52542	
0212	07774001	FAB SHIELD COMP SIDE IRID & S/SCR		1.000	52542	
0214	07774101	FAB SHIELD CKT SIDE IRID		1.000	52542	
0215	10062512	PHMS CRES 2-56 X 3/4		18.000	96906	MS51957-9
0216	100661	SPLIT LOCK#2 CRES		18.000	96906	MS35337-77

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Loops 2 and 9 PC Board Assembly A9, 07760201 (Figure 5-33)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707760201	SCHEM PCB LOOPS 2 & 9	REF	.000	52542	
0002	2077602	ARTWORK PCB LOOPS 2 & 9	REF	.000	52542	
0003	077602	FAB PCB LOOPS 2 & 9		1.000	52542	
0004	607760201	BLOCK DIAGRAM LOOPS 2 & 9	REF	.000	52542	
0006	117570	CAP CER DP .01 UF 100V 20% X7R	C2-4,31	26.000	04222	SR201C103MAA
0006	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	33,42,48	.000		
0006	99REF02	************* REF DESN'TORS CONT *************	53,54,59	.000		
0006	99REF03	************* REF DESN'TORS CONT *************	62,64,69	.000		
0006	99REF04	************* REF DESN'TORS CONT *************	71,75,77	.000		
0006	99REF05	************* REF DESN'TORS CONT *************	83,84,88	.000		
0006	99REF06	************* REF DESN'TORS CONT *************	90,102	.000		
0006	99REF07	************* REF DESN'TORS CONT *************	108,110	.000		
0006	99REF08	************* REF DESN'TORS CONT *************	112,114	.000		
0008	117628	CAP CER DP100PF 100V 5% COG .1LS<.1	C5,7,72	5.000	96733	DB44BY101J
0008	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	37,41	.000		
0010	11981901	CAP CER MLD 1.5NF 200V 10% COG .3SQ*.1TH .2LS	C6,8	2.000	96733	RH06BY152K
0011	117359	CAP CER DP47PF 100V 5% COG .1LS<.15	C12,40,	9.000	96733	DB44BY470J
0011	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	50,66	.000		
0011	99REF02	************* REF DESN'TORS CONT *************	92,113,	.000		
0011	99REF03	************* REF DESN'TORS CONT *************	115-117	.000		
0012	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C10,11	5.000		TAPB22M25
0012	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	70,87,89	.000		
0013	100155	CAP C MOLD .1 UF 50V 10%	C27,44,	15.000	32159	G505BX104K
0013	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	55,57,73	.000		
0013	99REF02	************* REF DESN'TORS CONT *************	74,76,95	.000		
0013	99REF03	************* REF DESN'TORS CONT *************	96,100,	.000		
0013	99REF04	************* REF DESN'TORS CONT *************	103,105	.000		
0013	99REF05	************* REF DESN'TORS CONT *************	109,118,	.000		
0013	99REF06	************* REF DESN'TORS CONT *************	127	.000		
0014	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C19,22,	4.000	56289	2C37Z5U105M050B
0014	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C97,98	.000		
0015	99REF50	******* REF DESN'TORS NOT USED **************	C13,14	.000		
0018	118923	CAP CER DP39PF 100V 5% COG .1LS	C18	1.000	96733	DB44BY390J
0020	117639	CAP CER DP 1000PF 5% 100V COG .1LS <.25Q	C15,20,	29.000	96733	DB45BY102J
0020	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	26,28,29	.000		
0020	99REF02	************* REF DESN'TORS CONT *************	30,32,34	.000		
0020	99REF03	************* REF DESN'TORS CONT *************	38,39,43	.000		
0020	99REF04	************* REF DESN'TORS CONT *************	56,58,67	.000		
0020	99REF05	************* REF DESN'TORS CONT *************	85,86,91	.000		
0020	99REF06	************* REF DESN'TORS CONT *************	93,94,99	.000		
0020	99REF07	************* REF DESN'TORS CONT *************	101,111	.000		
0020	99REF08	************* REF DESN'TORS CONT *************	120-126	.000		
0022	103716	CAP TANT 1UF 35V 10%	C1,9,21	3.000	56289	196D105X9035HA1
0024	106515	CAP TANT 6.8UF 35V 20% .25LS .23D	C23,24	2.000	56289	196D685X0035KE3
0025	116619	CAP C DP .047UF 10%/.056UF 20% 100V X7R .1LS	C61,68	3.000	51642	200-100-X7R563M
0025	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	119	.000		

REPLACEABLE PARTS LIST — Continued

Title: Loops 2 and 9 PC Board Assembly A9, 07760201 (Figure 5-33) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0026	117631	CAP CER DP180PF 100V 5% COG .1LS<.1	C25	1.000	96733	DB44BY181J
0028	117471	CAP CER DP33PF 100V 5% COG .1LS<.15	C35,36	2.000	96733	DB44BY330J
0029	100119	CAP TANT 100UF 10V 10%	C37,41	2.000	56289	150D107X9010R2
0030	117683	CAP CER DP20PF 100V 5% COG .1LS <.1	C45,47	2.000	51642	150-100NP0200J
0032	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C60,128	2.000	96733	DB44BY100J
0036	117626	CAP CER DP68PF 100V 5% COG .1LS <.1	C63	1.000	96733	DB44BY680J
0038	117623	CAP CER DP12PF 100V 5% COG .1LS <.1	C65	1.000	96733	DB44BY120J
0040	103929	CAP CER DP6800PF >50V 10% 30PPM/C	C78,79	4.000	20932	5032EO100RD682K
0040	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	80,81	.000		
0042	117629	CAP CER DP120PF 100V 5% COG .1LS<.1	C82	1.000	96733	DB44BY121J
0044	100063	CAP TANT 10UF 20V 10%	C104	1.000	56289	150D106X9020B2
0045	100125	CAP TANT 22UF 15V 10%	C106,107	2.000	56289	150D226X9015B2
0046	101566	RES CC 1/4W 220 OHMS 5%	R1	1.000	01121	CB2215
0048	101583	RES CC 1/4W 560 OHMS 5%	R2,22,26	4.000	01121	CB5615
0048	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	59	.000		
0050	101570	RES CC 1/4W 10K 5%	R3,4,86	3.000	01121	CB1035
0052	101574	RES CC 1/4W 47K 5%	R5,46	2.000	01121	CB4735
0054	11950201	RES MF 1.27K .1W 1% 50PPM/C <.14D*.28L	R6,7	2.000	91637	CMF 55 T2
0056	101558	RES CC 1/4W 100K 5%	R8,11,12	4.000	01121	CB1045
0056	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	17	.000		
0058	101569	RES CC 1/4W 1.0K 5%	R9,41,44	8.000	01121	CB1025
0058	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	83,85,96	.000		
0058	99REF02	************ REF DESN'TORS CONT *************	106,107	.000		
0060	101596	RES CC 1/4W 7.5K 5%	R10	1.000	01121	CB7525
0062	102157	RES MF 9.09K .12W 1% 100PPM	R13	1.000	19701	MF5C-D-9091-F
0064	11465501	RES CC 1/8W 2.0K 5%	R74,75	2.000	81349	RCR056202JS
0066	101940	RES CC 1/4W 20 OHMS 5%	R15	1.000	01121	CB2005
0070	101613	RES CC 1/4W 75K 5%	R99	1.000	01121	CB7535
0072	101547	RES CC 1/4W 36K 5%	R18	1.000	01121	CB3635
0074	101609	RES CC 1/4W 100 OHMS 5%	R19,20	5.000	01121	CB1015
0074	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	24,27,69	.000		
0075	101690	RES CC 1/4W 68 OHMS 5%	R21,117	2.000	01121	CB6805
0076	101584	RES CC 1/4W 5.6K 5%	R23,25	2.000	01121	CB5625
0078	101476	RES CC 1/2W 390 OHMS 5%	R28,35	3.000	01121	EB3915
0078	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	36	.000		
0079	101727	RES CC 1/4W 18 OHMS 5%	R29,31	4.000	01121	CB1805
0079	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	33,53	.000		
0080	101731	RES CC 1/4W 33 OHMS 5%	R30	1.000	01121	CB3305
0081	101537	RES CC 1/4W 300 OHMS 5%	R16,32	3.000	01121	CB3015
0081	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	34	.000		
0082	101696	RES CC 1/4W 22 OHMS 5%	R37,39	2.000	01121	CB2205
0083	101732	RES CC 1/4W 36 OHMS 5%	R38	1.000	01121	CB3605
0084	101672	RES CC 1/4W 51 OHMS 5%	R40,65	2.000	01121	CB5105
0085	101577	RES CC 1/4W 1.5K 5%	R42	1.000	01121	CB1525
0086	101567	RES CC 1/4W 820 OHMS 5%	R43	1.000	01121	CB8215
0087	101669	RES CC 1/4W 680 OHMS 5%	R45,48	5.000	01121	CB6815

REPLACEABLE PARTS LIST — Continued

Title: Loops 2 and 9 PC Board Assembly A9, 07760201 (Figure 5-33) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0087	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	55,97,98	.000		
0088	101710	RES CC 1/8W 560 OHMS 5%	R47	1.000	01121	BB5615
0089	101599	RES CC 1/4W 2.7K 5%	R49	1.000	01121	CB2725
0090	101689	RES CC 1/4W 750 OHMS 5%	R50	1.000	01121	CB7515
0091	99REF50	******* REF DESN'TORS NOT USED **************	R51,52	.000		
0092	101688	RES CC 1/4W 620 OHMS 5%	R54	1.000	01121	CB6215
0093	101746	RES CC 1/4W 160 OHMS 5%	R56	1.000	01121	CB1615
0094	101733	RES CC 1/4W 39 OHMS 5%	R57	1.000	01121	CB3905
0095	117860	RES MF 1.74K .1W 1% 100PPM <.28L	R60	1.000		C=RN55D1741F
0096	119096	RES MF 33.2K .1W 1% 25PPM/C <.14	R61	1.000	91637	CMF-55 T9
0097	119060	RES MF 15.8K .1W 1% 25PPM/C <.14	R62	1.000	91637	CMF-55 T9
0098	119029	RES MF 7.87K .1W 1% 25PPM/C <.14	R63	1.000	91637	CMF-55 T9
0099	10156201	RES CC 1/4W 2.2K 5% .4LS	R64,100	2.000	01121	CB2225
0100	119009	RES MF 5.11K .1W 1% 25PPM/C <.14	R66	1.000	91637	CMF-55 T9
0101	118991	RES MF 3.48K .1W 1% 25PPM/C <.14	R67	1.000	91637	CMF-55 T9
0102	102097	RES MF 1.00K .12W 1% 100PPM	14,68,70	8.000	19701	MF5C-D-1001 F
0102	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	72,87,88	.000		
0102	99REF02	************ REF DESN'TORS CONT *************	94,102	.000		
0104	101548	RES CC 1/4W 3.0K 5%	R71	1.000	01121	CB3025
0106	117587	RES MF 909 .1 W 1% 100PPM <.28L*	R73	1.000		C=RN55D9090F
0108	101900	RES CC 1/8W 2.4K 5%	R76,77	2.000	01121	BB2425
0109	102080	RES MF 100K .12W 1% 100PPM	R78	1.000	91637	MFF 1/8 T1
0111	119043	RES MF 10.5K .1W 1% 25PPM/C <.14	R80	1.000	91637	CMF-55 T9
0113	117551	POT 18T PC 500 OHMS .5W@70/C 10% ENDADJ	R81	1.000	73138	68XR500
0115	101581	RES CC 1/4W 1.2K 5%	R82	1.000	01121	CB1225
0117	103195	RES MF 200 1% .12W@125C 100PPM	R84	1.000	19701	MF5C-D-2000F
0119	620360	RES MF 1.50K .25W 1% 100PPM	R93	1.000		C=RN65D1501F
0121	620439	RES MF 2.37K .25W 1% 100PPM	R95,101	2.000		C=RN65D2371F
0123	102197	RES MF 3.16K .12W 1% 100PPM	R104,105	2.000	91637	MFF-1/8 T1
0125	101588	RES CC 1/4W 240 OHMS 5%	R108	1.000	01121	CB2415
0127	117811	RES MF 2.00K .1W 1% 100PPM	R109	1.000		C=RN55D2001F
0129	119005	RES MF 4.64K .1W 1% 25PPM/C <.14	R111,112	2.000	91637	CMF-55 T9
0131	10162501	RES CC 1/4W 470 OHMS 5% .4LS	R113	1.000	01121	CB4715
0133	101784	RES CC 1/4W 2.7 OHMS 5%	R114,116	2.000	01121	CB27G5
0135	101553	RES CC 1/4W 2.0K 5%	R115	1.000	01121	CB2025
0137	116600	RES MF 887 .1W 1% 100PPM <.28L*	R79	1.000		RN55D8870F
0139	106001	RES CC 1/4W 16 OHMS 5%	R118	1.000	01121	CB1605
0156	119968	RES MODULE 4@560 2% .2W/R@70C 851P <.25H	RN1,2	2.000	80294	4308R-102-561
0158	119970	RES MODULE 4@10K 2% .2W/R@70C 8SIP <.25H	RN3,7,8	3.000	80294	4308R-102-103
0160	027867	RES MODULE4-5K .1W 20% COMP CARBON	RN5	1.000	52542	MRG-C-5Y-5.1K-K
0162	100442	DIODE SIGL HP-2800 70V 100PS ULTRA FAST SW	CR1,2,4	3.000	28480	5082-2800
0164	100385	DIODE SGN1N4151 50V	CR3,9-12	6.000	03508	1N4151
0164	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	14	.000		
0166	123529	DIODE VCAP KV3201 11PF@3V 5PF@10V DO-34 CASE	CR5,13	2.000	50101	KV3201
0168	116527	DIODE VCAP32/26PF@3 6.5/5TR@25	CR6,7	2.000	04713	MV209
0170	100378	DIODE ZENR 5.1V .4W 5% 1N751A	CR8	1.000	03877	1N751A

REPLACEABLE PARTS LIST — Continued

Title: Loops 2 and 9 PC Board Assembly A9, 07760201 (Figure 5-33) – Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0172	720461	DIODE REF 1N823 6.2V 5% .005%/C 15R	CR15	1.000		1N823
0173	019330	DIODE ZENR 2.2V 5% 10MS	CR16,17	2.000	52542	
0174	12316806	INDUCT ADJ 1/2 TURN	L3	1.000	52542	
0175	101309	INDUCT FXD2.2UH 10% 36QMIN .12X.33	L4	1.000	00213	WEE-WEE-2.2
0176	101319	INDUCT FXD.15UH 20% 42QMIN .12X.33	L8	1.000	00213	WEE-WEE-0.15
0178	106682	IND. FXD .10UH PHENOLIC CORE	L9	1.000	99800	1025-94
0180	102854	INDUCT FXD.27UH 20% Q47 FO250MHZ	L10	1.000	00213	WEE-0.27
0181	12316803	INDUCT ADJ 2 3/4 TURNS	L11	1.000	52542	
0182	102670	INDUCT FXD15 UH 10% 47QMIN .16X.45	L12	1.000	00213	WEE-15
0184	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L13,14	2.000	02114	VK200-20/4B
0186	101323	INDUCT FXD.05UH 10% .10X.25	L15	1.000	06560	10150-17K
0188	103948	XSTR SI NPN BFR90 15V 25B50 @ 14 MA 5GHZ RF	Q2,3,9	3.000	04713	BFR90
0190	102696	XSTR SINPNPN3563 12V 20B200@8MA FT>	Q4,5	2.000	07263	PN3563-18
0192	101416	MOSFET NCHSPF1023 2GT 8-20MS X PKG	Q7	1.000	04713	SPF1023
0194	101378	XSTR SI PNP 2N3906 40V 100B300@10MA TO-92	Q8,11,19	4.000	04713	2N3906
0194	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	20	.000		
0196	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q10,18	2.000	04713	2N3904
0198	101358	XSTR SINPNPN3643 30V 100B300@.15A F	Q12	1.000	07263	PN3643-5
0200	101367	XSTR SIPNPPN3645 60V 80B240@50MA FT	Q13	1.000	07263	PN3645-18
0202	101429	XSTR SI PNP MPS6523 25V 100MA TO-92	Q14,15	3.000	04713	MPS6523
0202	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	16	.000		
0204	106617	XSTR SINPNMJE800 60V B>750@1.5A C77	Q17	1.000	04713	MJE800
0206	101375	JFET NCHNL2N5248 30V Y>3MS@200MHZ	Q21	1.000	01295	2N5248
0208	045277	IC ECL 12040 PHASE-FREQ DET	U1	1.000	04713	MC12040L
0210	103711	IC LIN MSCAM685 DIFF V CMPR .7.5NS	U2	1.000	34335	AM685HL
0212	119975	IC OP AMP 5532 DUAL LOW NOISE	U3,14,19	3.000	18324	NE5532AN
0214	116929	AMP HYBRID MWA120 0-400MHZ A14DB P>8.2DBM TO5	U4,5,6	3.000	04713	MWA120
0216	102815	MIX BAL 1-1000MHZ 6DBLOSS 40DBISO	U7	1.000	15542	SAM-2
0218	025792	IC LIN MSCLM311 COMPARATOR DIFF V	U8	1.000	27014	LM311H
0220	116928	AMP HYBRID MWA110 0-400MHZ A14DB P-2.5DBM TO5	U9,11	2.000	04713	MWA110
0222	117250	IC CMOS MSI IH5043 2*SPDT R<80 10V MAX INPUT	U10,16	2.000	32293	IH5043CPE
0223	123424	IC LIN MSC IH5053C QUAD SPST NO CMOS SWITCH	U13	1.000	32293	IH5053CJE
0224	11940501	IC LIN LM339A QUAD COMP EO<2MV IB<.25UA 14DIP	U15	1.000	27041	LM339AN
0228	045238	IC TTL MSI4044 PHASE-FREQUENCY DET.	U18	1.000	04713	MC4044P
0230	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-7	7.000	98291	51-053-0000
0231	100565	CON PC PINSINGLE MALE POST 10/INCH	W1,2	5.000	00779	86090-4
0232	119321	CON SHRTNGSKTS .032D@.1	W1,2	2.000	63058	MSB3604-100-SN200
0234	07761501	FAB SHIELD COMP SIDE IRID & S/SCR		1.000	52542	
0236	07761601	FAB SHIELD CKT SIDE IRID		1.000	52542	
0238	08326109	FAB MODULE TOP A9		1.000	013186	52542
0240	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0242	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0244	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0245	100661	SPLIT LOCK#2 CRES		22.000	96906	MS35337-77
0246	100575	TERM PRESSFDTH .086MTG .06MAT .515L	TP1,3-5	4.000	98921	001-1007
0248	100541	TEST POINTRED PC MT RIGHT ANGLE	TP2	1.000	74970	105-0852-001

REPLACEABLE PARTS LIST — Continued

Title: Loops 2 and 9 PC Board Assembly A9, 07760201 (Figure 5-33) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0249	10062512	PHMS CRES 2-56 X 3/4		22.000	96906	MS51957-9
0250	101117	MYLAR WSHR.225ID .363OD .007THK		5.000	86928	5622-26-7
0251	102879	JUMPER, 22AWG INSULATED .09D .25L		1.000	55210	L-2007-1

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Loops 3 and 4 PC Board Assembly A10, 07749301 (Figure 5-36)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707749301	SCHEM PCB LOOPS 3 & 4	REF	.000	52542	
0002	2077493	ARTWORK PCB LOOPS 3 & 4	REF	.000	52542	
0003	607749301	BLOCK DIAGRAM LOOPS 3 & 4	REF	.000	52542	
0004	07749201	FAB SHIELD CKT SIDE IRID		1.000	52542	
0005	07749101	FAB SHIELD COMP SIDE IRID & S/SCR		1.000	52542	
0006	077493	FAB PCB LOOPS 3 & 4		1.000	52542	
0009	117570	CAP CER DP .01 UF 100V 20% X7R	C1,5,6,8	25.000	04222	SR201C103MAA
0009	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	9,21,45,	.000		
0009	99REF02	************* REF DESN'TORS CONT **************	54,56,58	.000		
0009	99REF03	************* REF DESN'TORS CONT **************	62,64,65	.000		
0009	99REF04	************* REF DESN'TORS CONT **************	68,69,70	.000		
0009	99REF05	************* REF DESN'TORS CONT **************	73,75,76	.000		
0009	99REF06	************* REF DESN'TORS CONT **************	88,89,	.000		
0009	99REF07	************* REF DESN'TORS CONT **************	104-7	.000		
0017	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C2,19,23	7.000	56289	2C37Z5U105M050B
0017	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	26,42,44	.000		
0017	99REF02	************* REF DESN'TORS CONT **************	92	.000		
0021	117569	CAP CER DP4700PF 100V 20% X7R <.2SQ	C3,4	2.000	04222	3418100C472M
0023	117359	CAP CER DP47PF 100V 5% COG .1LS<.15	C7,34,77	9.000	96733	DB44BY470J
0023	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	78,79,84	.000		
0023	99REF02	************* REF DESN'TORS CONT **************	90,96,	.000		
0023	99REF03	************* REF DESN'TORS CONT **************	109	.000		
0027	117620	CAP CER DP2PF 100V .5PF COG	C10,11	2.000	96733	DB44BY2ROD
0029	117631	CAP CER DP180PF 100V 5% COG .1LS<.1	C12,13,	3.000	96733	DB44BY181J
0029	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	49	.000		
0031	100155	CAP C MOLD .1 UF 50V 10%	C14,15,	17.000	32159	G505BX104K
0031	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	20,28,29	.000		
0031	99REF02	************* REF DESN'TORS CONT **************	30,40,46	.000		
0031	99REF03	************* REF DESN'TORS CONT **************	47,51,52	.000		
0031	99REF04	************* REF DESN'TORS CONT **************	59,74,95	.000		
0031	99REF05	************* REF DESN'TORS CONT **************	98,119,	.000		
0031	99REF06	************* REF DESN'TORS CONT **************	120	.000		
0032	103935	CAP VARCER1-5PF 100V -.035%/C <.2D	C17	1.000	72982	513-012A1-5
0043	116501	CAP CER DP 2200PF 100V 10% X7R.15SQ .1LS	C22,86	3.000	96733	DB44BX222K
0043	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	87	.000		
0045	117639	CAP CER DP 1000PF 5% 100V COG .1LS <.25Q	C25,31,	29.000	96733	DB45BY102J
0045	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	32,33,36	.000		
0045	99REF02	************* REF DESN'TORS CONT **************	50,60,61	.000		
0045	99REF03	************* REF DESN'TORS CONT **************	66,67,72	.000		
0045	99REF04	************* REF DESN'TORS CONT **************	80,82,94	.000		
0045	99REF05	************* REF DESN'TORS CONT **************	97,99,	.000		
0045	99REF06	************* REF DESN'TORS CONT **************	100-102,	.000		
0045	99REF07	************* REF DESN'TORS CONT **************	108,110	.000		
0045	99REF08	************* REF DESN'TORS CONT **************	111,112	.000		
0045	99REF09	************* REF DESN'TORS CONT **************	113-118	.000		
0056	116619	CAP C DP .047UF 10%/.056UF 20% 100V X7R .1LS	C38,39,	3.000	51642	200-100-X7R563M

REPLACEABLE PARTS LIST — *Continued*

Title: Loops 3 and 4 PC Board Assembly A10, 07749301 (Figure 5-36) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0056	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C91	.000		
0058	123405	CAP C MOLD .22UF 50V 10% X7R .2LS .3SQ <.15TH	C41	1.000	56289	CKR06BX224KL
0060	117471	CAP CER DP33PF 100V 5% COG .1LS<.15	C43,85	2.000	96733	DB44BY330J
0062	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C53,55	5.000		TAPB22M25
0062	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	57,63,71	.000		
0064	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C121	1.000	96733	DB44BY100J
0065	103716	CAP TANT 1UF 35V 10%	C81,83	2.000	56289	196D105X9035HA1
0066	117635	CAP CER DP270PF 100V 5% COG .1LS<.2	C93	1.000	96733	DB45BY271J
0067	100442	DIODE SIGL HP-2800 70V 100PS ULTRA FAST SW	CR1,2,4,	7.000	28480	5082-2800
0067	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	5,20,21,	.000		
0067	99REF02	************ REF DESN'TORS CONT *************	22	.000		
0069	100410	DIODE SGNL15V .85PF STEP RECOV	CR3	1.000	28480	5082-0151
0071	100385	DIODE SGN1N4151 50V	CR6,8,9	8.000	03508	1N4151
0071	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	14,16,17	.000		
0071	99REF02	************ REF DESN'TORS CONT *************	18,19	.000		
0075	123529	DIODE VCAP KV3201 11PF@3V 5PF@10V DO-34 CASE	CR10-13	6.000	50101	KV3201
0075	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	23,24	.000		
0079	100443	DIODE SGNL1N4829 20V 1.87V FWD	CR15	1.000	03508	1N4829
0084	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-6	6.000	98291	51-053-0000
0086	123275	INDUCT FXD 4.7UH 10% .21L*.09D Q>35@7.9MHZ	L1	1.000	00213	PW-4.7
0088	101324	INDUCT FXD.33UH 10% 30QMIN .10X.25	L3	1.000	06560	4416-7K
0090	11992401	INDUCT FXD .082UH 10% .1D*.25L Q733	L4	1.000	71279	551-5172-08-02-00
0092	123736	INDUCT FXD .082UH 10% .1D*.25L Q733	L5	1.000		
0094	106688	IND FXD .56UH PHENOLIC CORE	L6	1.000	99800	1025-14
0096	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L7,9,12	3.000	02114	VK200-20/4B
0098	101320	INDUCT FXD100UH 10% 43QMIN .12X.33	L8	1.000	00213	WEE-WEE-100
0102	101326	INDUCT FXD1.5UH 10% 38QMIN .12X.33	L10,15	2.000	00213	WEE-WEE-1.5
0104	12316802	INDUCT ADJ 3/4 TURN	L16	1.000	52542	
0106	112294	FERRITE BEAD .138OD .047ID .118L BS=2900GAUSS	L17-21	5.000	02114	56-590-65/4A
0110	103414	XSTR SINPNBFR91 12V >25@30MA 5GHZ	Q1,2	2.000	25403	BFR91
0112	101383	JFET PCHNL2N5461 40V 1.5Y5MS 2ID9MA	Q3	1.000	04713	2N5461
0114	101391	XSTR SIPNP2N4959	Q4,11	2.000	04713	2N4959
0116	103948	XSTR SI NPN BFR90 15V 25B50 @ 14 MA 5GHZ RF	Q5,6,12	4.000	04713	BFR90
0116	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	Q13	.000		
0119	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q7,8	2.000	04713	2N3904
0121	101409	JFET NCHNL2N4091 40V R<30 -10VP-5V	Q14	1.000	04713	2N4091
0122	101701	RES CC 1/8W 100 OHMS 5%	R1,9	3.000	01121	BB1015
0122	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	10	.000		
0125	101609	RES CC 1/4W 100 OHMS 5%	R32,51,	10.000	01121	CB1015
0125	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	55,57,69	.000		
0125	99REF02	************ REF DESN'TORS CONT *************	73,87,88	.000		
0125	99REF03	************ REF DESN'TORS CONT *************	106,119	.000		
0129	101973	RES CC 1/8W 820 OHMS 5%	R2	1.000	01121	BB8215
0130	101804	RES CC 1/8W 510 OHMS 5%	R3	1.000	01121	BB5115
0131	101698	RES CC 1/8W 15K 5%	R4	1.000	01121	BB1535
0132	101569	RES CC 1/4W 1.0K 5%	R5,24,	6.000	01121	CB1025

REPLACEABLE PARTS LIST — Continued

Title: Loops 3 and 4 PC Board Assembly A10, 07749301 (Figure 5-36) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0132	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	96-99	.000		
0133	11465501	RES CC 1/8W 2.0K 5%	R6	1.000	81349	RCR056202JS
0134	620210	RES MF 604 .5W@70C 1% 100PPM	R7	1.000		C=RN65D6040F
0135	101914	RES CC 1/8W 130 OHMS 5%	R8	1.000	01121	BB1315
0138	101694	RES CC 1/8W 47K 5%	R11,12	2.000	01121	BB4735
0140	101711	RES CC 1/8W 1.0K 5%	R13	1.000	01121	BB1025
0142	101572	RES CC 1/4W 22K 5%	R14,15,	2.000	01121	CB2235
0143	102097	RES MF 1.00K .12W 1% 100PPM	R16,17	2.000	19701	MF5C-D-1001 F
0144	101597	RES CC 1/4W 68K 5%	R18	1.000	01121	CB6835
0145	103194	RES MF 806 1% .12W@125C 100PPM	R19	1.000	91637	CMF-60 T1
0146	101580	RES CC 1/4W 120K 5%	R20	1.000	01121	CB1245
0147	101598	RES CC 1/4W 4.7K 5%	R21,89	2.000	01121	CB4725
0148	101558	RES CC 1/4W 100K 5%	R22,23,	3.000	01121	CB1045
0148	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	60	.000		
0151	123139	RES MF 100 .1W 1% 25PPM/C <.14D * .281L	R33,47	2.000	91637	CMF-55 T9
0152	101570	RES CC 1/4W 10K 5%	R25-27	8.000	01121	CB1035
0152	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	42,61,62	.000		
0152	99REF02	************ REF DESN'TORS CONT *************	84,85	.000		
0153	117576	RES MF 4.99K .1W 1% 100PPM <.28	R28	1.000		C=RN55D4991F
0157	101599	RES CC 1/4W 2.7K 5%	R29	1.000	01121	CB2725
0158	117599	RES MF 267 .1 W 1% 100PPM <.28L*	R30	1.000		C=RN55D2670F
0159	101704	RES CC 1/8W 330 OHMS 5%	R31	1.000	01121	BB3315
0161	118953	RES MF 1.50K .1W 1% 25PPM/C <.14	R34,48	2.000	91637	CMF-55 T9
0162	117585	RES MF 10.0K .1 W 1% 100PPM .28L	R35	1.000		C=RN55D1002F
0163	101574	RES CC 1/4W 47K 5%	R36,86	2.000	01121	CB4735
0164	106169	RES MF 15.0K .12W 1% 50PPM	R37	1.000		RN60C1502F
0165	101709	RES CC 1/8W 470 OHMS 5%	R38	1.000	0112	BB4715
0166	101815	RES CC 1/8W 51 OHMS 5%	R39	1.000	01121	BB5105
0167	117588	RES MF 33.2 .1 W 1% 100PPM <.28L	R40	1.000		C=RN55D33R2F
0168	101764	RES CC 1/4W 15 OHMS 5%	R41	1.000	01121	CB1505
0169	117813	RES MF 6.19K .1W 1% 100PPM	R43	1.000		C=RN55D6191F
0170	117859	RES MF 402 .1W 1% 100PPM <.28L*	R44	1.000		C=RN55D4020F
0171	118985	RES MF 3.01K .1W 1% 25PPM/C <.14	R45	1.000	91637	CMF-55 T9
0172	119941	RES MF 200 .1W 1% 25PPM	R46	1.000		C=RN55E2000F
0173	102252	RES MF 750 .12W 1% 100PPM	R49	1.000	91637	MFF 1/8 T1
0174	102090	RES MF 49.9 .1 W 1% 25PPM	R50	1.000	19701	MF4C-E-49R9 F
0175	101710	RES CC 1/8W 560 OHMS 5%	R52,58	4.000	01121	BB5615
0175	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	107,112	.000		
0176	101715	RES CC 1/8W 5.6K 5%	R53,54	4.000	01121	BB5625
0176	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	108,109	.000		
0177	116977	POT 20T PC 50K 10% .5W@25C TOPADJ	R56	1.000	73138	66WR50K
0178	101720	RES CC 1/8W 180 OHMS 5%	R110	1.000	0112	BB1815
0181	101588	RES CC 1/4W 240 OHMS 5%	R63	1.000	01121	CB2415
0182	112284	RES CC 1/4W 1.0 OHMS 10%	R64,66,	3.000		WC025K
0182	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	68	.000		
0184	101672	RES CC 1/4W 51 OHMS 5%	R65,67	2.000	01121	CB5105

REPLACEABLE PARTS LIST — Continued

Title: Loops 3 and 4 PC Board Assembly A10, 07749301 (Figure 5-36) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0185	101784	RES CC 1/4W 2.7 OHMS 5%	R70,72	2.000	01121	CB27G5
0186	101625	RES CC 1/4W 470 OHMS 5%	R71	1.000	01121	CB4715
0187	101690	RES CC 1/4W 68 OHMS 5%	R76,78	2.000	01121	CB6805
0188	101566	RES CC 1/4W 220 OHMS 5%	R77,79	4.000	01121	CB2215
0188	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	91,94	.000		
0189	101745	RES CC 1/4W 360 OHMS 5%	R80-83	4.000	01121	CB3615
0191	101733	RES CC 1/4W 39 OHMS 5%	R90,95	2.000	01121	CB3905
0192	101586	RES CC 1/4W 200K 5%	R92	1.000	01121	CB2045
0194	101562	RES CC 1/4W 2.2K 5%	R100,101	2.000	01121	CB2225
0195	101616	RES CC 1/4W 510 OHMS 5%	R102	1.000	01121	CB5115
0196	101590	RES CC 1/4W 51K 5%	R103	1.000	01121	CB5135
0197	101707	RES CC 1/8W 47 OHMS 5%	R113	1.000	01121	BB4705
0198	99REF50	******* REF DESN'TORS NOT USED **************	R114	.000		
0200	101627	RES CC 1/4W 130 OHMS 5%	R115	1.000	01121	CB1315
0201	101557	RES CC 1/4W 10 OHMS 5%	R118,120	2.000	01121	CB1005
0202	101774	RES CC 1/4W 430 OHMS 5%	R117	1.000	01121	CB4315
0207	045008	RES MODULE4-12K .1W 20% COMP CARBON	RN1	1.000	52542	MRG-C-5Y-12K-K
0210	117093	IC OP AMP LF356A 94DB IB<50PA <5UV/	U2	1.000	27014	LF356AH
0211	118742	IC OP AMP A88DB IB1.5UA <7NV/(HZ)E.5 10MHZ	U3,7	2.000	18324	NE5534AN
0212	117703	IC OP AMP TL072 2JFET A68DB 10UV/C	U5	1.000	01295	TL072CP
0213	116930	AMP HYBRID MWA130 0-400MHZ A14DB P>18DBM TO5	U6	1.000	04713	MWA130
0214	123003	IC LIN MPQ3904 QUAD NPN XSTR 40V	U8	1.000	04713	MPQ3904
0215	08315402	ASSY PROM PRGM 1501/2-A10-U9	U9	1.000	52542	
0216	08315403	ASSY PROM PRGRM 1501/2-A10-U10	U10	1.000	52542	
0217	118868	IC VOLTREF +10.00V +-5MV 5PPM/C TO-5 PKG	U11	1.000	24335	AD581LH
0218	123037	DAC IC AD7533KN 10BIT MULTI 0.1% LIN (1LSB)	U12	1.000	24335	AD7533KN
0219	116590	IC OP AMP TL074 4JFET A68DB 10UV/C	U13	1.000	01295	TL074CN
0220	123408	IC LIN MPQ6002 QUAD NPN XSTR 25V	U14,15	2.000	04713	MPQ6002
0221	045277	IC ECL 12040 PHASE-FREQ DET	U16	1.000	04713	MC12040L
0222	119975	IC OP AMP 5532 DUAL LOW NOISE	U17	1.000	18324	NE5532AN
0223	99REF50	******* REF DESN'TORS NOT USED **************	U18	.000		
0224	103416	IC ECL MSI 11C90DC DUAL MOD (10/11) PRESCALER	U19	1.000	07263	11C90DC
0228	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0229	10062512	PHMS CRES 2-56 X 3/4		23.000	96906	MS51957-9
0230	100661	SPLIT LOCK#2 CRES		23.000	96906	MS35337-77
0231	103224	HEATSINK DIP .25W.75L.19H .02W/C E		2.000	13103	6011B
0232	083108	FAB SAMPLER TRANSMISSION LINE	T1	2.000	52542	
0233	08326110	FAB MODULE TOP A10		1.000	52542	
0234	101117	MYLAR WSHR.225ID .363OD .007THK	(U11)	1.000	86928	5622-26-7
0235	10063205	PHMS CRES 6-32 X 5/16		3.000	96906	MS51957-27
0236	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0238	117041	SOCKET IC 16PIN .4W(.3SP)X.82L <.160H SN CON	XU9,10	2.000	71279	703-1316-01-04-10
0240	077211	CRYSTAL 100MHZ	Y1	1.000	52542	
0242	100565	CON PC PINSINGLE MALE POST 10/INCH	W1,2	11.000	00779	86090-4
0242	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	TP5-10	.000		
0244	119321	CON SHRTNGSKTS .032D@.1	W1,2	2.000	63058	MSB3604-100-SN200

REPLACEABLE PARTS LIST — Continued

Title: Loops 3 and 4 PC Board Assembly A10, 07749301 (Figure 5-36) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION		REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0246	100541	TEST POINTRED	PC MT RIGHT ANGLE	TP2-4	3.000	74970	105-0852-001

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Divide-by-N and Divide-by-P PC Board Assembly A11, 07753201 (Figure 5-39)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707753201	SCHEM PCB DIVIDE BY N & P	REF	.000	52542	
0002	2077532	ARTWORK PCB DIVIDE BY N & P	REF	.000	52542	
0003	077532	FAB PCB DIVIDE BY N & P		1.000	52542	
0004	607753201	BLOCK DIAGRAM DIVIDE BY N & P	REF	.000	52542	
0005	117570	CAP CER DP .01 UF 100V 20% X7R	C1,4,7	21.000	04222	SR201C103MAA
0005	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C9-14	.000		
0005	99REF02	************ REF DESN'TORS CONT *************	C22-24	.000		
0005	99REF03	************ REF DESN'TORS CONT *************	C26-28	.000		
0005	99REF04	************ REF DESN'TORS CONT *************	C30-33	.000		
0005	99REF05	************ REF DESN'TORS CONT *************	C37,38	.000		
0007	117568	CAP CER DP1000PF 100V 10% X7R .15SQ	C2,8	14.000	04222	3418100C102K
0007	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	15-17	.000		
0007	99REF02	************ REF DESN'TORS CONT *************	19-21	.000		
0007	99REF03	************ REF DESN'TORS CONT *************	25,29,34	.000		
0007	99REF04	************ REF DESN'TORS CONT *************	35,41,42	.000		
0008	100178	CAP CER DP .1UF 50V 20% Z5U .38LS .36HI .3SQ	C3	1.000	56289	2C37Z5U104M050B
0009	103714	CAP TANT 100UF 10V 10% RDL .25LS	C5	1.000	56289	196D107X9010PE4
0010	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C6	1.000		TAPB22M25
0012	117628	CAP CER DP100PF 100V 5% COG .1LS<.1	C18,39	2.000	96733	DB44BY101J
0040	117631	CAP CER DP180PF 100V 5% COG .1LS<.1	C36	1.000	96733	DB44BY181J
0041	117637	CAP CER DP470PF 100V 5% COG .1LS<.2	C40	1.000	96733	DB45BY471J
0045	100442	DIODE SIGL HP-2800 70V 100PS ULTRA FAST SW	CR1,2	2.000	28480	5082-2800
0050	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-3	3.000	98291	51-053-0000
0054	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L1,2	2.000	02114	VK200-20/4B
0060	112097	XSTR SIPNP MJE700 60V 4A B>750@1.5A TO-205AA	Q1	1.000	04713	MJE700
0061	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q2,4	2.000	04713	2N3904
0067	101735	RES CC 1/4W 56 OHMS 5%	R1,30	2.000	0112	CB5605
0068	101557	RES CC 1/4W 10 OHMS 5%	R2	1.000	01121	CB1005
0069	101536	RES CC 1/4W 330 OHMS 5%	R15,36	2.000	01121	CB3315
0074	101625	RES CC 1/4W 470 OHMS 5%	R8	1.000	01121	CB4715
0075	101583	RES CC 1/4W 560 OHMS 5%	R4-7,9	12.000	01121	CB5615
0075	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	17,25,26	.000		
0075	99REF02	************ REF DESN'TORS CONT *************	R28,32	.000		
0075	99REF03	************ REF DESN'TORS CONT *************	R34,37	.000		
0076	101689	RES CC 1/4W 750 OHMS 5%	R10	1.000	01121	CB7515
0077	101774	RES CC 1/4W 430 OHMS 5%	R3	1.000	01121	CB4315
0078	101570	RES CC 1/4W 10K 5%	R12,16	7.000	01121	CB1035
0078	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R18-20	.000		
0078	99REF02	************ REF DESN'TORS CONT *************	R14,33	.000		
0079	101561	RES CC 1/4W 39K 5%	R13	1.000	01121	CB3935
0080	101602	RES CC 1/4W 1.8K 5%	R23	1.000	01121	CB1825
0095	101592	RES CC 1/4W 390 OHMS 5%	R27,29	4.000	01121	CB3915
0095	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R35,38	.000		
0096	101601	RES CC 1/4W 3.9K 5%	R39	1.000	01121	CB3925
0098	123225	RES MODULE 7-560 2% .2W R@75C 8SIP 250PPM<.2H	RN1,7	2.000	80294	4308P-101-561
0099	119981	RES MODULE 8@10K 2% .25W/R@70C 16DIP	RN2-6	5.000	80294	4116R-001-103

REPLACEABLE PARTS LIST — Continued

Title: Divide-by-N and Divide-by-P PC Board Assembly A11, 07753201 (Figure 5-39) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0100	119980	IC ECL MSI 11C91DC DIV 5/6 650MHZ PRESCALER	U1	1.000	07263	11C91DC
0102	103027	IC ECL 10137P/L SYNC UP/DWN CNTR PRSET >100MH	U3,9,23	6.000	04713	MC10137P
0102	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	U28-30	.000		
0105	103974	IC TTL MSI74LS85 4BIT MAGTD CMPR	U6	1.000	01295	SN74LS85N
0106	116322	IC TTL MSI74LS138 3-8LINE DECODER	U7	1.000	27014	DM74LS138N
0109	103025	IC ECL 10102 QUAD 2IN NOR,1OR	U8,10,33	3.000	04713	MC10102P
0110	045239	IC ECL 10131 DUAL D M-S FLIPFLOP	U11,34	2.000	04713	MC10131P
0112	119978	IC CMOS 74HC374 OCTAL D-TYPE FLIP-FLOP	U13,21	3.000	27014	MM74HC374N
0112	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	U22	.000		
0113	117955	IC TTL MSI74LS245 8 3ST XCUR ^INV	U14	1.000	01295	SN74LS245
0114	103749	IC TTL SSI74LS04 HEX INV <20NS	U15,19	2.000	01295	SN74LS04N
0116	103976	IC TTL SSI74LS123 DUAL RETRIG 1SHOT	U17,24	2.000	01295	SN74LS123N
0117	117508	IC TTL MSI74LS244 8BFR 2ENBL LINEDR	U18	1.000	01295	SN74LS244N
0130	103416	IC ECL MSI 11C90DC DUAL MOD (10/11) PRESCALER	U31	1.000	07263	11C90DC
0131	100565	CON PC PINSINGLE MALE POST 10/INCH	TP1-3	3.000	00779	86090-4
0133	103224	HEATSINK DIP .25W.75L.19H .02W/C E		8.000	13103	6011B
0135	08326211	FAB MODULE TOP A11		1.000	52542	
0137	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0139	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0141	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0145	075602	HEATSINK, FIXED L.O. BD		1.000		
0146	10062607	PHMS CRES 4-40 X 7/16		1.000	96906	MS51957-16
0147	100622	NUT HEX 4-40 .19AF .06THK SS		1.000	80205	NAS671C4
0148	103351	WSHR CPRSN.27OD.12ID.05H CASE 77		1.000	04713	B52200F003
0149	103352	INS XISTORTO-220 .61/.48W.75/.69L>.		1.000	08289	SK-73-48-13
0150	103397	NYLON WSHRSHLD TO-220 MOT199-04		1.000	02735	DF137A
0151	100703	FLAT WSHR #4 .125 ID.250 OD CRES		1.000	96906	MS15795-803
0152	10312601	ADHESIVE HI THERM COND EPOX HEATSI	A/R	.000		4951

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Divide-by-Q PC Board Assembly A12, 07751501 (Figure 5-42)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707751501	SCHEM PCB DIVIDE BY Q	REF	.000	52542	
0002	2077515	ARTWORK PCB DIVIDE BY Q	REF	.000	52542	
0003	607751501	BLOCK DIAGRAM DIV N#2 A12	REF	.000	52542	
0007	077515	FAB PCB DIVIDE BY Q		1.000	52542	
0010	100251	CAP C MOLD 1000PF 50V 20%	C1,23,49	6.000	71590	CW15C102M
0010	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	50,56,57	.000		
0011	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C3	1.000	56289	2C37Z5U105M050B
0012	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C4,53	2.000		TAPB22M25
0013	100178	CAP CER DP .1UF 50V 20% Z5U .38LS .36HI .3SQ	C6,7,15	6.000	56289	2C37Z5U104M050B
0013	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	46,48,51	.000		
0018	117570	CAP CER DP .01 UF 100V 20% X7R	C14	26.000	04222	SR201C103MAA
0018	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C24-45	.000		
0018	99REF02	************ REF DESN'TORS CONT *************	47,52,55	.000		
0022	117775	CAP CER DP91PF 100V 5% COG <.2SQ.1L	C18	1.000	51642	200-100NP0910J
0023	117624	CAP CER DP15PF 100V 5% COG .1LS <.1	C19	1.000	96733	DB44BY150J
0024	117628	CAP CER DP100PF 100V 5% COG .1LS<.1	C20	1.000	96733	DB44BY101J
0025	118923	CAP CER DP39PF 100V 5% COG .1LS	C21	1.000	96733	DB44BY390J
0026	117626	CAP CER DP68PF 100V 5% COG .1LS <.1	C22	1.000	96733	DB44BY680J
0028	117683	CAP CER DP20PF 100V 5% COG .1LS <.1	C54	1.000	51642	150-100NP0200J
0034	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-5	5.000	98291	51-053-0000
0040	106682	IND. FXD .10UH PHENOLIC CORE	L1,L3	2.000	99800	1025-94
0041	101322	INDUCT FXD.06UH 10% 40QMIN .10X.25	L2	1.000	06560	10150-2
0042	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L4	1.000	02114	VK200-20/4B
0047	101367	XSTR SIPNPPN3645 60V 80B240@50MA FT	Q1	1.000	07263	PN3645-18
0050	101378	XSTR SI PNP 2N3906 40V 100B300@10MA TO-92	Q5	1.000	04713	2N3906
0055	101735	RES CC 1/4W 56 OHMS 5%	R1	1.000	0112	CB5605
0057	101583	RES CC 1/4W 560 OHMS 5%	R4	1.000	01121	CB5615
0058	101542	RES CC 1/4W 270 OHMS 5%	R6	1.000	01121	CB2715
0059	101774	RES CC 1/4W 430 OHMS 5%	R5	1.000	01121	CB4315
0060	101554	RES CC 1/4W 24K 5%	R11,27	2.000	01121	CB2435
0061	101729	RES CC 1/4W 27 OHMS 5%	R12,29	2.000	0112	CB2705
0062	101579	RES CC 1/4W 18K 5%	R20	1.000	01121	CB1835
0063	101672	RES CC 1/4W 51 OHMS 5%	R23	1.000	01121	CB5105
0068	112284	RES CC 1/4W 1.0 OHMS 10%	R28	1.000		WC025K
0069	101555	RES CC 1/4W 200 OHMS 5%	R30	1.000	01121	CB2015
0070	101625	RES CC 1/4W 470 OHMS 5%	R25	1.000	01121	CB4715
0072	101668	RES CC 1/4W 180 OHMS 5%	R24	1.000	01121	CB1815
0081	103416	IC ECL MSI 11C90DC DUAL MOD (10/11) PRESCALER	U1,11,12	3.000	07263	11C90DC
0082	103837	IC ECL MSI10138 2*5CNTR >100MHZ 4SE	U2	1.000	04713	MC10138P
0083	116322	IC TTL MSI74LS138 3-8LINE DECODER	U3	1.000	27014	DM74LS138N
0084	103749	IC TTL SSI74LS04 HEX INV <20NS	U4	1.000	01295	SN74LS04N
0085	103106	IC TTL MSI74LS192 SYN BCD UP/DOWN C	U5,7-10	5.000	01295	SN74LS192N
0086	045263	IC TTL MSICOUNTER CONTROL LOGIC MC12014L	U6	1.000	04713	MC12014L
0087	025786	IC TTL SSI74S112 DUAL J-K FLIP FLOP	U13,25	2.000	01295	SN74S112N
0088	103974	IC TTL MSI74LS85 4BIT MAGTD CMPR	U14	1.000	01295	SN74LS85N
0090	117955	IC TTL MSI74LS245 8 3ST XCUR ^INV	U16	1.000	01295	SN74LS245

REPLACEABLE PARTS LIST — Continued

Title: Divide-by-Q PC Board Assembly A12, 07751501 (Figure 5-42) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0091	116556	IC TTL MSI74LS374 8 D EDG-TRG F/F	U17-19	3.000	01295	SN74LS374N
0092	103976	IC TTL SSI74LS123 DUAL RETRIG ISHOT	U20,26	2.000	01295	SN74LS123N
0093	103967	IC TTL SSI74LS08 4 2-IN AND	U21	1.000	01295	SN74LS08N
0094	116554	IC TTL MSI74LS90 DEC CNTR <30MHZ	U22	1.000	01295	SN74LS90N
0095	119976	IC TTL MSI74LS390 DUAL 4BIT DECADE COUNTER	U23,24	2.000	01295	SN74LS390N
0097	116929	AMP HYBRID MWA120 0-400MHZ A14DB P>8.2DBM TO5	U27	1.000	04713	MWA120
0098	100575	TERM PRESSFDTH .086MTG .06MAT .515L	TP1-3	3.000	98921	001-1007
0099	103224	HEATSINK DIP .25W.75L.19H .02W/C E		3.000	13103	6011B
0100	08326212	FAB MODULE TOP A12		1.000	52542	
0102	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0104	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0106	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0108	10312601	ADHESIVE HI THERM COND EPOX HEATSI	A/R	.000		4951

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Loops 5, 6, and 7 PC Board Assembly A13, 07754201 (Figure 5-45)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707754201	SCHEM PCB LOOPS 5,6 & 7	REF	.000	52542	
0002	2077542	ARTWORK PCB LOOPS 5,6 & 7	REF	.000	52542	
0003	607754201	BLOCK DIAGRAM A13	REF	.000	52542	
0007	077542	FAB PCB LOOPS 5,6 & 7		1.000	52542	
0008	117639	CAP CER DP 1000PF 5% 100V COG .1LS <.25Q	C1,6,8	27.000	96733	DB45BY102J
0008	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	22,25-27	.000		
0008	99REF02	************* REF DESN'TORS CONT *************	29,31,32	.000		
0008	99REF03	************* REF DESN'TORS CONT *************	38,40,41	.000		
0008	99REF04	************* REF DESN'TORS CONT *************	48,60,63	.000		
0008	99REF05	************* REF DESN'TORS CONT *************	64,66,89	.000		
0008	99REF06	************* REF DESN'TORS CONT *************	91,96	.000		
0008	99REF07	************* REF DESN'TORS CONT *************	92-94	.000		
0008	99REF08	************* REF DESN'TORS CONT *************	98,101	.000		
0008	99REF09	************* REF DESN'TORS CONT *************	107	.000		
0009	100155	CAP C MOLD .1 UF 50V 10%	C2,4,9	26.000	32159	G505BX104K
0009	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	10,11,13	.000		
0009	99REF02	************* REF DESN'TORS CONT *************	24,28,30	.000		
0009	99REF03	************* REF DESN'TORS CONT *************	35,36,42	.000		
0009	99REF04	************* REF DESN'TORS CONT *************	47,49,58	.000		
0009	99REF05	************* REF DESN'TORS CONT *************	61,62,67	.000		
0009	99REF06	************* REF DESN'TORS CONT *************	68,70,84	.000		
0009	99REF07	************* REF DESN'TORS CONT *************	87,90,95	.000		
0009	99REF08	************* REF DESN'TORS CONT *************	99,105	.000		
0010	117359	CAP CER DP47PF 100V 5% COG .1LS<.15	C3,102	4.000	96733	DB44BY470J
0010	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	106,108	.000		
0011	116501	CAP CER DP 2200PF 100V 10% X7R.15SQ .1LS	C5,45	2.000	96733	DB44BX222K
0013	99REF09	************* REF DESN'TORS CONT *************	C98,101	.000		
0015	117570	CAP CER DP .01 UF 100V 20% X7R	C7,19,39	8.000	04222	SR201C103MAA
0015	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C56,71	.000		
0015	99REF02	************* REF DESN'TORS CONT *************	C85,86	.000		
0015	99REF03	************* REF DESN'TORS CONT *************	C103	.000		
0018	106515	CAP TANT 6.8UF 35V 20% .25LS .23D	C12,14	8.000	56289	196D685X0035KE3
0018	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	15,16,50	.000		
0018	99REF02	************* REF DESN'TORS CONT *************	53,76,78	.000		
0020	117569	CAP CER DP4700PF 100V 20% X7R <.2SQ	C17,54	2.000	04222	3418100C472M
0021	11981901	CAP CER MLD 1.5NF 200V 10% COG .3SQ*.1TH .2LS	C18,55	2.000	96733	RH06BY152K
0023	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C20	10.000		TAPB22M25
0023	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C43,44	.000		
0023	99REF02	************* REF DESN'TORS CONT *************	C46,59	.000		
0023	99REF03	************* REF DESN'TORS CONT *************	C65,72	.000		
0023	99REF04	************* REF DESN'TORS CONT *************	C79,97	.000		
0023	99REF05	************* REF DESN'TORS CONT *************	C100	.000		
0024	117631	CAP CER DP180PF 100V 5% COG .1LS<.1	C21,57	2.000	96733	DB44BY181J
0024	117637	CAP CER DP470PF 100V 5% COG .1LS<.2	C88	1.000	96733	DB45BY471J
0027	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C23	1.000	96733	DB44BY100J
0029	117625	CAP CER DP56PF 100V 5% COG .1LS <.1	C33,34	2.000	96733	DB44BY560J

REPLACEABLE PARTS LIST — Continued

Title: Loops 5, 6, and 7 PC Board Assembly A13, 07754201 (Figure 5-45) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0031	103716	CAP TANT 1UF 35V 10%	C37	1.000	56289	196D105X9035HA1
0032	116619	CAP C DP .047UF 10%/.056UF 20% 100V X7R .1LS	C51,52	2.000	51642	200-100-X7R563M
0034	123239	CAP C MOLD/DIP .47UF 50V 5% .30SQ <.15TH .2LS	C69	1.000	96733	G506BX474J
0035	100372	CAP C MOLD3300PF 100V 10% NPO 30PPM	C73,74	2.000	26654	2130C0G100R332K
0037	123405	CAP C MOLD .22UF 50V 10% X7R .2LS .3SQ <.15TH	C75,77	2.000	56289	CKR06BX224KL
0039	103929	CAP CER DP6800PF >50V 10% 30PPM/C	C80-83	4.000	20932	5032E0100RD682K
0041	106513	CAP TANT 4.7UF 20V 20% RAD LEADS	C104	1.000	56289	196D475X0035JA1
0062	100385	DIODE SGN1N4151 50V	CR1-3,6	9.000	03508	1N4151
0062	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	CR7,10	.000		
0062	99REF02	************ REF DESN'TORS CONT *************	CR13,15	.000		
0062	99REF03	************ REF DESN'TORS CONT *************	CR16	.000		
0064	123529	DIODE VCAP KV3201 11PF@3V 5PF@10V DO-34 CASE	CR4,5,8	4.000	50101	KV3201
0064	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	CR9	.000		
0065	116527	DIODE VCAP32/26PF@3 6.5/5TR@25	CR11,12	2.000	04713	MV209
0066	100442	DIODE SIGL HP-2800 70V 100PS ULTRA FAST SW	CR17,18	2.000	28480	5082-2800
0072	101306	INDUCT FXD100UH 5% 63QMIN .16X.45	L1,9	2.000	00213	WEE-100
0073	106688	IND FXD .56UH PHENOLIC CORE	L2,10	2.000	99800	1025-14
0074	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L3,6	5.000	02114	VK200-20/4B
0074	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	L12,13	.000		
0074	99REF02	************ REF DESN'TORS CONT *************	L17	.000		
0075	101323	INDUCT FXD.05UH 10% .10X.25	L8	1.000	06560	10150-17K
0076	102670	INDUCT FXD15 UH 10% 47QMIN .16X.45	L15	1.000	00213	WEE-15
0077	106686	IND. FXD .47UH PHENOLIC CORE	L16	1.000	99800	1025-12
0078	12316804	INDUCT ADJ 1 3/4 TURNS	L18,19	2.000	52542	
0079	12316809	INDUCT ADJ 1 3/4 TURNS	L20	1.000		
0080	101316	INDUCT FXD47 UH 10% 42QMIN .12X.33	L21-24	4.000	00213	WEE-WEE-47
0081	102696	XSTR SINPNPN3563 12V 20B200@8MA FT>	Q1,2	2.000	07263	PN3563-18
0083	103948	XSTR SI NPN BFR90 15V 25B50 @ 14 MA 5GHZ RF	Q3,4,9	6.000	04713	BFR90
0083	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	10,18,19	.000		
0085	101367	XSTR SIPNPPN3645 60V 80B240@50MA FT	Q5,8,11	4.000	07263	PN3645-18
0085	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	20	.000		
0088	101358	XSTR SINPNPN3643 30V 100B300@.15A F	Q6,7	6.000	07263	PN3643-5
0088	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	Q12-14	.000		
0088	99REF02	************ REF DESN'TORS CONT *************	Q23	.000		
0095	101429	XSTR SI PNP MPS6523 25V 100MA TO-92	Q15-17	3.000	04713	MPS6523
0097	101375	JFET NCHNL2N5248 30V Y>3MS@200MHZ	Q21,22	2.000	01295	2N5248
0100	101688	RES CC 1/4W 620 OHMS 5%	R1	1.000	01121	CB6215
0101	101536	RES CC 1/4W 330 OHMS 5%	R2	1.000	01121	CB3315
0102	101589	RES CC 1/4W 1.1K 5%	R4	1.000	01121	CB1125
0104	101570	RES CC 1/4W 10K 5%	R5,6	2.000	01121	CB1035
0106	101574	RES CC 1/4W 47K 5%	R7,39	2.000	01121	CB4735
0108	101625	RES CC 1/4W 470 OHMS 5%	R8	1.000	01121	CB4715
0110	102134	RES MF 127 .12W 1% 100PPM	R9,10	2.000	19701	MF5C-D-1270F
0111	101557	RES CC 1/4W 10 OHMS 5%	R12,20	6.000	01121	CB1005
0111	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	53,89,91	.000		
0111	99REF02	************ REF DESN'TORS CONT *************	94	.000		

REPLACEABLE PARTS LIST — Continued

Title: Loops 5, 6, and 7 PC Board Assembly A13, 07754201 (Figure 5-45) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0112	101609	RES CC 1/4W 100 OHMS 5%	R11,21	10.000	01121	CB1015
0112	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	23,29,54	.000		
0112	99REF02	************* REF DESN'TORS CONT *************	55,64,76	.000		
0112	99REF03	************* REF DESN'TORS CONT *************	77,86	.000		
0114	101754	RES CC 1/4W 11K 5%	R13	1.000	01121	CB1135
0116	101558	RES CC 1/4W 100K 5%	R14-16	3.000	01121	CB1045
0118	102148	RES MF 40.2K .12W 1% 100PPM	R17	1.000	19701	MF5C-D-4022-F
0119	118988	RES MF 3.24K .1W 1% 25PPM/C <.14	R18	1.000	91637	CMF-55 T9
0120	101774	RES CC 1/4W 430 OHMS 5%	R19	1.000	01121	CB4315
0122	106001	RES CC 1/4W 16 OHMS 5%	R22	1.000	01121	CB1605
0123	101616	RES CC 1/4W 510 OHMS 5%	R24,56	2.000	01121	CB5115
0124	101592	RES CC 1/4W 390 OHMS 5%	R25	1.000	01121	CB3915
0126	101710	RES CC 1/8W 560 OHMS 5%	R26,31	5.000	01121	BB5615
0126	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	57,62,85	.000		
0128	101715	RES CC 1/8W 5.6K 5%	R27,28	6.000	01121	BB5625
0128	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	58,59	.000		
0128	99REF02	************* REF DESN'TORS CONT *************	81,82	.000		
0130	101701	RES CC 1/8W 100 OHMS 5%	R30,61	3.000	01121	BB1015
0130	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	84	.000		
0132	101476	RES CC 1/2W 390 OHMS 5%	R32,37	4.000	01121	EB3915
0132	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	66,88	.000		
0133	101569	RES CC 1/4W 1.0K 5%	R33,44	8.000	01121	CB1025
0133	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R63,87	.000		
0133	99REF02	************* REF DESN'TORS CONT *************	R92,93	.000		
0133	99REF03	************* REF DESN'TORS CONT *************	R100,101	.000		
0134	101727	RES CC 1/4W 18 OHMS 5%	R34,68	2.000	01121	CB1805
0136	101732	RES CC 1/4W 36 OHMS 5%	R35	1.000	01121	CB3605
0138	101729	RES CC 1/4W 27 OHMS 5%	R36	1.000	0112	CB2705
0140	101583	RES CC 1/4W 560 OHMS 5%	R38,48	2.000	01121	CB5615
0141	101689	RES CC 1/4W 750 OHMS 5%	R40	1.000	01121	CB7515
0142	101542	RES CC 1/4W 270 OHMS 5%	R41,49	2.000	01121	CB2715
0143	101614	RES CC 1/4W 1.6K 5%	R42	1.000	01121	CB1625
0144	101577	RES CC 1/4W 1.5K 5%	R43	1.000	01121	CB1525
0147	101672	RES CC 1/4W 51 OHMS 5%	R45	1.000	01121	CB5105
0148	101690	RES CC 1/4W 68 OHMS 5%	R46	1.000	01121	CB6805
0149	101552	RES CC 1/4W 15K 5%	R47	1.000	01121	CB1535
0153	106178	RES MF 2.74K .12W 1% 50PPM	R51,52	2.000		RN60C2781F
0154	101555	RES CC 1/4W 200 OHMS 5%	R60	1.000	01121	CB2015
0155	101548	RES CC 1/4W 3.0K 5%	R65	1.000	01121	CB3025
0156	101729	RES CC 1/4W 27 OHMS 5%	R67	1.000	0112	CB2705
0158	101736	RES CC 1/4W 62 OHMS 5%	R69	1.000	01121	CB6205
0159	101996	RES CC 1/4W 6.8 OHMS 5%	R70	1.000	01121	CB68G5
0160	101734	RES CC 1/4W 43 OHMS 5%	R71	1.000	01121	CB4305
0161	101608	RES CC 1/4W 6.2K 5%	R50,73	2.000	01121	CB6225
0162	117595	RES MF 22.1K .1 W 1% 100PPM <.28	R74,75	2.000		RN55D2212F
0163	101594	RES CC 1/4W 13K 5%	R78	1.000	01121	CB1335

REPLACEABLE PARTS LIST — Continued

Title: Loops 5, 6, and 7 PC Board Assembly A13, 07754201 (Figure 5-45) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0164	101711	RES CC 1/8W 1.0K 5%	R79,80	2.000	01121	BB1025
0165	119133	RES MF 75.0K .1W 1% 25PPM/C <.14	R83,99	2.000	91637	CMF-55 T9
0166	101615	RES CC 1/4W 150 OHMS 5%	R90,95	2.000	01121	CB1515
0168	102040	RES CC 1/8W 220K 5%	R96	1.000	01121	BB2245
0170	101694	RES CC 1/8W 47K 5%	R97	1.000	01121	BB4735
0172	101792	RES CC 1/8W 4.7K 5%	R98	1.000	01121	BB4725
0180	119968	RES MODULE 4@560 2% .2W/R@70C 851P <.25H	RN1	1.000	80294	4308R-102-561
0182	119969	RES MODULE 4@1K 2% .2W/R@70C 8SIP <.25H	RN2	1.000	80294	4308R-102-102
0184	119970	RES MODULE 4@10K 2% .2W/R@70C 8SIP <.25H	RN3,4,7	4.000	80294	4308R-102-103
0184	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	RN8	.000		
0186	119971	RES MODULE 4@4.7K 2% .2W/R@70C 8S1P <.25H	RN9	1.000	80294	4308R-102-472
0188	119972	RES MODULE 5@4.7K 2% .13W/R@70C 6S1P <.25H	RN10	1.000	80294	4306R-101-472
0190	045008	RES MODULE4-12K .1W 20% COMP CARBON	RN11	1.000	52542	MRG-C-5Y-12K-K
0192	119974	RES MODULE 5@3.9K 2% .13W/4@70C 6S1P <.25H	RN12	1.000	80294	4306R-101-392
0200	045277	IC ECL 12040 PHASE-FREQ DET	U2	1.000	04713	MC12040L
0202	103943	IC LIN MISC LM311N TYPE DIFF COMPAR	U3	1.000	01295	SN72311P
0204	119975	IC OP AMP 5532 DUAL LOW NOISE	U4,10,13	4.000	18324	NE5532AN
0204	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	U16	.000		
0206	116929	AMP HYBRID MWA120 0-400MHZ A14DB P>8.2DBM TO5	U5,6,11	3.000	04713	MWA120
0210	103711	IC LIN MSCAM685 DIFF V CMPR .7.5NS	U8	1.000	34335	AM685HL
0212	045238	IC TTL MSI4044 PHASE-FREQUENCY DET.	U9,12	2.000	04713	MC4044P
0214	116928	AMP HYBRID MWA110 0-400MHZ A14DB P-2.5DBM TO5	U14	1.000	04713	MWA110
0216	102815	MIX BAL 1-1000MHZ 6DBLOSS 40DBISO	U15	1.000	15542	SAM-2
0218	100575	TERM PRESSFDTH .086MTG .06MAT .515L	TP1-9	9.000	98921	001-1007
0220	100565	CON PC PINSINGLE MALE POST 10/INCH	W1-4	8.000	00779	86090-4
0221	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0222	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0223	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0226	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-3	3.000	98291	51-053-0000
0230	08326113	FAB MODULE TOP A13		1.000	52542	
0232	07756901	FAB SHIELD COMP SIDE IRID & S/SCR		1.000	52542	
0234	07757001	FAB SHIELD CKT SIDE IRID		1.000	52542	
0236	10062512	PHMS CRES 2-56 X 3/4		36.000	96906	MS51957-9
0237	100661	SPLIT LOCK#2 CRES		36.000	96906	MS35337-77
0238	119321	CON SHRTNGSKTS .032D@.1	W1-4	4.000	63058	MSB3604-100-SN200
0241	07784101	ASSY SEMI RIGID LOOP 7 REF		1.000	52542	
0242	07784201	ASSY SEMI RIGID LOOP 7 FEEDBACK		1.000	52542	
0243	07784301	ASSY SEMI RIGID LOOP 6 REF		1.000	52542	
0244	07784401	ASSY SEMI RIGID LOOP 6 FEED BACK		1.000	52542	
0246	07784601	ASSY SEMI RIGID LOOP 5 COARSE TUNE		1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Reference Frequency Generator PC Board Assembly A14, 07743401 (Figure 5-48)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707743401	SCHEM PCB REF FREQ GENERATOR		.000	52542	
0002	2077434	ARTWORK PCB REF FREQ GENERATOR		.000	52542	
0003	077434	FAB PCB REF FREQ GENERATOR		1.000	52542	
0004	607743401	BLOCK DIAGRAM REF FREQ GEN	REF	.000	52542	
0005	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C1,4,6,9	4.000		TAPB22M25
0006	100178	CAP CER DP .1UF 50V 20% Z5U .38LS .36HI .3SQ	C2,5,8	8.000	56289	2C37Z5U104M050B
0006	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	11,26,31	.000		
0006	99REF02	************ REF DESN'TORS CONT *************	78,94	.000		
0007	117351	CAP C DISC .01UF 50V 20% Y5F <.29D	C3,12-14	15.000	71590	UK50-103
0007	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C16,17	.000		
0007	99REF02	************ REF DESN'TORS CONT *************	C22,24	.000		
0007	99REF03	************ REF DESN'TORS CONT *************	C25,35	.000		
0007	99REF04	************ REF DESN'TORS CONT *************	C64,65	.000		
0007	99REF05	************ REF DESN'TORS CONT *************	C83-85	.000		
0008	117570	CAP CER DP .01 UF 100V 20% X7R	C7,30,43	17.000	04222	SR201C103MAA
0008	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	50,53,57	.000		
0008	99REF02	************ REF DESN'TORS CONT *************	70,71,77	.000		
0008	99REF03	************ REF DESN'TORS CONT *************	79,80	.000		
0008	99REF04	************ REF DESN'TORS CONT *************	86-88,90	.000		
0008	99REF05	************ REF DESN'TORS CONT *************	92,93	.000		
0010	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C10,18	5.000	56289	2C37Z5U105M050B
0010	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	52,56,58	.000		
0019	117639	CAP CER DP 1000PF 5% 100V COG .1LS <.25Q	C15,23,	17.000	96733	DB45BY102J
0019	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	29,32,91	.000		
0019	99REF02	************ REF DESN'TORS CONT *************	C33,37	.000		
0019	99REF03	************ REF DESN'TORS CONT *************	C46,48	.000		
0019	99REF04	************ REF DESN'TORS CONT *************	C60	.000		
0019	99REF05	************ REF DESN'TORS CONT *************	C62,66	.000		
0019	99REF06	************ REF DESN'TORS CONT *************	C72-76	.000		
0021	103715	CAP TANT 10UF >10V 10%	C19,20	2.000	56289	196D106X9020JA1
0022	117633	CAP CER DP220PF 100V 5% COG .1LS<.1	C21	1.000	96733	DB44BY221J
0031	117359	CAP CER DP47PF 100V 5% COG .1LS<.15	C27,28	4.000	96733	DB44BY470J
0031	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C36,38	.000		
0038	116619	CAP C DP .047UF 10%/.056UF 20% 100V X7R .1LS	C34,39	6.000	51642	200-100-X7R563M
0038	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	45,61,63	.000		
0038	99REF02	************ REF DESN'TORS CONT *************	67	.000		
0044	118923	CAP CER DP39PF 100V 5% COG .1LS	C40,51,	3.000	96733	DB44BY390J
0044	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	96	.000		
0045	117624	CAP CER DP15PF 100V 5% COG .1LS <.1	C41	1.000	96733	DB44BY150J
0046	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C42,97	2.000	96733	DB44BY100J
0047	106512	CAP TANT 33UF 25V 20% RAD LEAD	C44,68,	3.000	56289	196D336X0025PE4
0047	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C69	.000		
0051	117623	CAP CER DP12PF 100V 5% COG .1LS <.1	C47	1.000	96733	DB44BY120J
0053	117626	CAP CER DP68PF 100V 5% COG .1LS <.1	C49	1.000	96733	DB44BY680J
0055	117638	CAP CER DP680PF 100V 5% COG .1LS<.2	C54,95	2.000	96733	DB45BY681J
0059	100155	CAP C MOLD .1 UF 50V 10%	C55	1.000	32159	G505BX104K

REPLACEABLE PARTS LIST — Continued

Title: Reference Frequency Generator PC Board Assembly A14, 07743401 (Figure 5-48) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0060	117358	CAP CER DP4.7PF 100V COG <.15W	C59	1.000	71590	CN10A4R7D
0062	117628	CAP CER DP100PF 100V 5% COG .1LS<.1	C89	1.000	96733	DB44BY101J
0064	117637	CAP CER DP470PF 100V 5% COG .1LS<.2	C81,82	2.000	96733	DB45BY471J
0090	100385	DIODE SGN1N4151 50V	CR1,5	5.000	03508	1N4151
0090	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	9-11	.000		
0091	100442	DIODE SIGL HP-2800 70V 100PS ULTRA FAST SW	CR2-4	3.000	28480	5082-2800
0093	100447	DIODE PIN 47273 <.3PF@50V R<5@10MA	CR6-8	3.000	96067	MA47273
0096	11990901	DIODE VCAP 6.8PF@4V 10% 2.7<TR<3.1@2-30V DO-7	VR1	1.000	04713	IN5461A
0097	101729	RES CC 1/4W 27 OHMS 5%	R1	1.000	0112	CB2705
0099	101625	RES CC 1/4W 470 OHMS 5%	R2,3,13	6.000	01121	CB4715
0099	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	14,55,78	.000		
0103	101542	RES CC 1/4W 270 OHMS 5%	R4	1.000	01121	CB2715
0104	101558	RES CC 1/4W 100K 5%	R5,32,35	4.000	01121	CB1045
0104	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	64	.000		
0105	101609	RES CC 1/4W 100 OHMS 5%	R6	1.000	01121	CB1015
0106	101774	RES CC 1/4W 430 OHMS 5%	R8	1.000	01121	CB4315
0107	101616	RES CC 1/4W 510 OHMS 5%	R9-11,22	11.000	01121	CB5115
0107	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	25,58-62	.000		
0107	99REF02	************* REF DESN'TORS CONT **************	R68	.000		
0111	101577	RES CC 1/4W 1.5K 5%	R12,71	3.000	01121	CB1525
0111	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	84	.000		
0113	101476	RES CC 1/2W 390 OHMS 5%	R15	1.000	01121	EB3915
0114	101727	RES CC 1/4W 18 OHMS 5%	R16,18	3.000	01121	CB1805
0114	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R19	.000		
0116	101735	RES CC 1/4W 56 OHMS 5%	R17	1.000	0112	CB5605
0118	101546	RES CC 1/4W 4.3K 5%	R20	1.000	01121	CB4325
0121	101570	RES CC 1/4W 10K 5%	R21,24,	12.000	01121	CB1035
0121	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	38,39,	.000		
0121	99REF02	************* REF DESN'TORS CONT **************	41-43,54	.000		
0121	99REF03	************* REF DESN'TORS CONT **************	73,77,85	.000		
0121	99REF04	************* REF DESN'TORS CONT **************	86	.000		
0123	101669	RES CC 1/4W 680 OHMS 5%	R23	1.000	01121	CB6815
0126	117860	RES MF 1.74K .1W 1% 100PPM <.28L	R27	1.000		C=RN55D1741F
0127	101569	RES CC 1/4W 1.0K 5%	R26,28,	5.000	01121	CB1025
0127	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	50,52,87	.000		
0128	119096	RES MF 33.2K .1W 1% 25PPM/C <.14	R29	1.000	91637	CMF-55 T9
0129	119060	RES MF 15.8K .1W 1% 25PPM/C <.14	R30	1.000	91637	CMF-55 T9
0130	119029	RES MF 7.87K .1W 1% 25PPM/C <.14	R31	1.000	91637	CMF-55 T9
0132	101587	RES CC 1/4W 27K 5%	R34	1.000	01121	CB2735
0134	101549	RES CC 1/4W 30K 5%	R36	1.000	01121	CB3035
0135	101620	RES CC 1/4W 300K 5%	R88	1.000	01121	CB3045
0139	101562	RES CC 1/4W 2.2K 5%	R40,69	6.000	01121	CB2225
0139	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R65-67	.000		
0139	99REF03	************* REF DESN'TORS CONT **************	R70	.000		
0140	101583	RES CC 1/4W 560 OHMS 5%	R44	1.000	01121	CB5615
0143	101598	RES CC 1/4W 4.7K 5%	R56	1.000	01121	CB4725

REPLACEABLE PARTS LIST — Continued

Title: Reference Frequency Generator PC Board Assembly A14, 07743401 (Figure 5-48) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0144	101589	RES CC 1/4W 1.1K 5%	R45	1.000	01121	CB1125
0145	101672	RES CC 1/4W 51 OHMS 5%	R46	1.000	01121	CB5105
0146	118955	RES MF 1.58K .1W 1% 25PPM/C <.14	R47	1.000	91637	CMF-55 T9
0147	116980	RES MF 5.11K .1W 1% 50PPM <.14D*	R48	1.000	16299	NC55 5.11K 1%
0148	118991	RES MF 3.48K .1W 1% 25PPM/C <.14	R49	1.000	91637	CMF-55 T9
0150	101595	RES CC 1/4W 8.2K 5%	R51	1.000	01121	CB8225
0151	101536	RES CC 1/4W 330 OHMS 5%	R57	1.000	01121	CB3315
0152	101608	RES CC 1/4W 6.2K 5%	R53	1.000	01121	CB6225
0153	106001	RES CC 1/4W 16 OHMS 5%	R74	1.000	01121	CB1605
0155	101537	RES CC 1/4W 300 OHMS 5%	R63	1.000	01121	CB3015
0168	101567	RES CC 1/4W 820 OHMS 5%	R72	1.000	01121	CB8215
0170	101732	RES CC 1/4W 36 OHMS 5%	R75,76	4.000	01121	CB3605
0171	112284	RES CC 1/4W 1.0 OHMS 10%	R79,80	2.000		WC025K
0173	101557	RES CC 1/4W 10 OHMS 5%	R81,82	2.000	01121	CB1005
0174	101559	RES CC 1/4W 3.3K 5%	R83	1.000	01121	CB3325
0175	119105	RES MF 41.2K .1W 1% 25PPM/C <.14	R89	1.000	91637	CMF-55 T9
0178	116554	IC TTL MSI74LS90 DEC CNTR <30MHZ	U1,2,4,6	4.000	01295	SN74LS90N
0180	116324	IC TTL MSI74LS93 4BIT BINARY CNTR	U3	1.000	01295	SN74LS93N
0182	103837	IC ECL MSI10138 2*5CNTR >100MHZ 4SE	U5	1.000	04713	MC10138P
0184	103130	IC TTL SSI74LS00 QUAD 2IN NAND GATE	U7,8	2.000	01295	SN74LS00N
0186	116929	AMP HYBRID MWA120 0-400MHZ A14DB P>8.2DBM TO5	U9	1.000	04713	MWA120
0187	103416	IC ECL MSI 11C90DC DUAL MOD (10/11) PRESCALER	U10	1.000	07263	11C90DC
0188	117703	IC OP AMP TL072 2JFET A68DB 10UV/C	U11,12	2.000	01295	TL072CP
0190	025792	IC LIN MSCLM311 COMPARATOR DIFF V	U13,14	2.000	27014	LM311H
0191	103025	IC ECL 10102 QUAD 2IN NOR,10R	U15,18	2.000	04713	MC10102P
0193	123408	IC LIN MPQ6002 QUAD NPN XSTR 25V	U16,17	2.000	04713	MPQ6002
0195	116525	IC TTL SSI74S140 2 4IN NAND 50R LND	U19	1.000	01295	SN74S140N
0197	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q15,17,	3.000	04713	2N3904
0197	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	18	.000		
0199	103735	XSTR SINPNPN2222A 40V 100B300@.15A	Q6	1.000	27018	PN2222A
0201	101378	XSTR SI PNP 2N3906 40V 100B300@10MA TO-92	Q11,16	2.000	04713	2N3906
0203	101430	XSTR SI NPN MPS6521 25V 100MA TO-92	Q8,12	2.000	04713	MPS6521
0204	101416	MOSFET NCHSPF1023 2GT 8-20MS X PKG	Q9	1.000	04713	SPF1023
0205	103948	XSTR SI NPN BFR90 15V 25B50 @ 14 MA 5GHZ RF	Q10	1.000	04713	BFR90
0208	119183	MOSFET NCHVN10KM 60V,<.5A,<2.5V@.5A	Q13	1.000	17856	VN10KM
0209	102675	XSTR SI PNP PN4258-18 12V ULTRA-HI-SPD SWITCH	Q14	1.000	07293	PN4258-18
0219	106682	IND. FXD .10UH PHENOLIC CORE	L3,4,7	3.000	99800	1025-94
0221	101324	INDUCT FXD.33UH 10% 30QMIN .10X.25	L5,9	2.000	06560	4416-7K
0222	101325	INDUCT FXD.82UH 20% 35QMIN .12X.33	L8	1.000	7225	WEE-WEE-0.82
0226	123786	INDUCT ADJ 5.5 TURNS SHIELED	L10	1.000	02113	146-05J08S
0227	103006	INDUCT FXD.22UH 20% QGT42 FGT414MHZ	L11	1.000	78526	DKM -.22
0228	101334	INDUCT FXD1.2UH 10% 43QMIN .16X.45	L12	1.000	00213	WEE-1.2
0232	077211	CRYSTAL 100MHZ	Y1	1.000	52542	
0236	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J1-7	7.000	98291	51-053-0000
0243	100565	CON PC PINSINGLE MALE POST 10/INCH	W1,2,3,	5.000	00779	86090-4
0243	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	TP1	.000		

REPLACEABLE PARTS LIST — Continued

Title: Reference Frequency Generator PC Board Assembly A14, 07743401 (Figure 5-48) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0244	119321	CON SHRTNGSKTS .032D@.1	W2	1.000	63058	MSB3604-100-SN200
0245	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0246	08326214	FAB MODULE TOP A14		1.000	52542	
0247	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0249	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: CPU PC Board Assembly A15, 07733101 (Figure 5-51)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707733101	SCHEM PCB CPU	REF	.000	52542	
0002	2077331	ARTWORK PCB CPU	REF	.000	52542	
0003	607733101	BLOCK DIAGRAM MICROPROCESSOR & IEEE A3	REF	.000	52542	
0004	083523	BLOCK DIAGRAM MICROPROCESSOR & IEEE A3	REF	1.000		
0007	077331	FAB PCB CPU		1.000	52542	
0009	117570	CAP CER DP .01 UF 100V 20% X7R	C1-10,12	24.000	04222	SR201C103MAA
0009	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C15,17	.000		
0009	99REF02	************ REF DESN'TORS CONT *************	C24-30	.000		
0009	99REF03	************ REF DESN'TORS CONT *************	C34,40	.000		
0009	99REF04	************ REF DESN'TORS CONT *************	C37,41	.000		
0013	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C11	1.000	56289	2C37Z5U105M050B
0016	100119	CAP TANT 100UF 10V 10%	C35,39	2.000	56289	150D107X9010R2
0019	117568	CAP CER DP1000PF 100V 10% X7R .15SQ	C38	1.000	04222	3418100C102K
0025	100385	DIODE SGN1N4151 50V	CR2,3	2.000	03508	1N4151
0029	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L1,2	2.000	02114	VK200-20/4B
0034	101548	RES CC 1/4W 3.0K 5%	R1-3	3.000	01121	CB3025
0035	101630	RES CC 1/4W 470K 5%	R5	1.000	01121	CB4745
0038	101559	RES CC 1/4W 3.3K 5%	R6	1.000	01121	CB3325
0042	101609	RES CC 1/4W 100 OHMS 5%	R13	1.000	01121	CB1015
0046	123464	SW PM SNGL SPDT MOM RTANGLE PC MT .1A@28V MAX	S1	1.000		AB-15AV
0049	116322	IC TTL MSI74LS138 3-8LINE DECODER	U1,13	2.000	27014	DM74LS138N
0051	119757	XTLOS 4MHZ TTL 14D1P FOR UP USE	U2	1.000	57693	TM80141DS 4.00MHZ
0052	045208	IC LIN NE555V TIMER WIDE-RANGE 500MA MAX IOUT	U3	1.000	18324	NE555V
0053	103749	IC TTL SSI74LS04 HEX INV <20NS	U4	1.000	01295	SN74LS04N
0054	116285	IC MC6802 1MHZ 8BIT MPU,CLOCK,RAM 40DIP .6W	U5	1.000	04713	MC6802P
0055	08315901	ASSY EPROM PROG 150X MAIN-MICRO A15	(U6-8)	1.000	52542	
0056	11944001	IC STATIC RAM 4016-45 2KX8 3ST<450NS 24PIN	U9	1.000	01295	TMS4016-45NL
0058	116573	IC LIN MSCMC3447 BI-TRANSCVR.3 24DI	U11,27	2.000	04713	MC3447P3
0063	103972	IC TTL SSI74LS32 4 2-IN OR	U17	1.000	01295	SN74LS32N
0064	11984401	IC TTL 74LS240 8 INV 3ST BUFF/LINE DRVR 20DIP	U18	1.000	01295	SN74LS240N
0065	116556	IC TTL MSI74LS374 8 D EDG-TRG F/F	U19	1.000	01295	SN74LS374N
0066	117955	IC TTL MSI74LS245 8 3ST XCUR ^INV	U20	1.000	01295	SN74LS245
0067	103132	IC TTL 74LS74A DUAL D F/F W/SET&CLEAR	U22	1.000	01295	SN74LS74N
0069	118750	IC MICMPTRPROGRAMABLE TIMER	U25	1.000	04713	MC6840P
0070	116430	IC MC68488 IEEE488 1MHZ 40DIP .6W	U26	1.000	04713	MC68488P
0071	11964701	CON PC PIN 2*13 RTANG HDR.1C-C W/LOCKS	J1	1.000	75037	3429-1203
0072	410008	SOCKET IC 40 PIN DIP PC BRG HI-REL .6SP G/T	XU5	1.000	06776	ICT-406-S-TG
0073	116143	SOCKET IC 28PIN .7W(.6SP)X1.42L <.160H SN CON	XU6-8	3.000	71279	703-1328-01-04-10
0075	103845	SOCKET IC 24PIN .7W(.6SP)X1.22L <.160H SN CON	XU10,12	2.000	71279	703-1324-01-04-10
0077	100565	CON PC PINSINGLE MALE POST 10/INCH	W1-5	15.000	00779	86090-4
0078	119321	CON SHRTNGSKTS .032D@.1	W1-5	5.000	63058	MSB3604-100-SN200
0091	10063208	PHMS CRES 6-32 X 1/2		3.000	96906	MS51957-30
0092	100712	SPLIT LOCK#6 CRES		3.000	96906	MS35338-136
0093	100489	SPCR RTANG6-32 .06MAT.31X.38.191MTG		3.000	88245	1590 B
0094	08326315	FAB MODULE TOP A15		1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Power Supply PC Board Assembly A16, 07751001 (Figure 5-53)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	2077510	ARTWORK PCB POWER SUPPLY	REF	.000	52542	
0002	077510	FAB PCB POWER SUPPLY		1.000	52542	
0003	707751001	SCHEM PCB POWER SUPPLY	REF	.000	52542	
0004	507778601	WIRE LIST PWR SUPPLY PC ASSY		1.000	52542	
0007	106228	RES MF 243 .12W 1% 100PPM	R6,10,12	5.000	16299	NA60
0007	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R14,16	.000		
0008	103195	RES MF 200 1% .12W@125C 100PPM	R18	1.000	19701	MF5C-D-2000F
0009	102068	RES MF 1.02K .1W 1% 100PPM	R7	1.000		RN55D1021F
0010	118986	RES MF 3.09K .1W 1% 25PPM/C <.14	R11,13	4.000	91637	CMF-55 T9
0010	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R15,17	.000		
0011	102480	RES ,F 3/92K .1W 1% 100PPM	R19	1.000	91637	CMF-55 3921 T1
0012	101569	RES CC 1/4W 1.0K 5%	R5	1.000	01121	CB1025
0013	101595	RES CC 1/4W 8.2K 5%	R4	1.000	01121	CB8225
0014	117404	RES NEG TC 1K @ 25C -4.4%/C 7MW/C 19S	R3	1.000	83186	31 D 10
0015	101476	RES CC 1/2W 390 OHMS 5%	R20	1.000	01121	EB3915
0016	101455	RES CC 1/2W 1.2K 5%	R21,22	2.000	01121	EB1225
0017	101510	RES CC 1/2W 6.8K 5%	R23	1.000	01121	EB6825
0019	123057	CAP EL CAN12000UF 35V 1.75D*3.125L LOW POST	C15,22	2.000		EMC123B635S
0020	11958801	CAP EL CAN 4700UF 35V 20% 25D*40MM	C32	1.000		35RPE4700
0021	123178	CAP EL CAN 4700UF 16V 20% .71D X 1.4H	C7	1.000	74840	478RMR016M
0022	123369	CAP EL CAN 4700UF 63V -20/+50% .63D.98L.3LS	C29	1.000	74840	477RMR063M
0023	821027	CAP TANT 15UF 35V 20%<.38D<.66H	C9,17,20	5.000	56289	196D156X0035PE4
0023	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C24,27	.000		
0024	103716	CAP TANT 1UF 35V 10%	C6,8,10	13.000	56289	196D105X9035HA1
0024	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	16,18,19	.000		
0024	99REF02	************ REF DESN'TORS CONT *************	21,23,25	.000		
0024	99REF03	************ REF DESN'TORS CONT *************	26,28,33	.000		
0024	99REF04	************ REF DESN'TORS CONT *************	C34	.000		
0025	117267	CAP METMYL1UF 100V 20% <.71L*.36T*.	C31	1.000	55112	60H105M100
0026	106421	CAP METMYL.1UF 200V 1%	C30	1.000	14752	210B1C104F
0032	123182	IC VOLTREG LM350K 1.2-33V@3A TO-3 0 TO 125C	U5	1.000	27014	LM350K
0034	118774	TUBE SHRNK.06EXP .63L BLK PLYO		2.000	06090	RNF100TYP1 1/16
0035	118766	TUBE SHRNK.25EXP .13RECVRD.WHT PLYO		.020	06090	RNF-100TYP1 1/4
0041	100385	DIODE SGN1N4151 50V	CR1,2	2.000	03508	1N4151
0042	720419	DIODE ZENRIN4747A 20V 5% 1W50CA	CR4	1.000		IN4747A
0043	100376	DIODE ZENR 5.6V .4W 5% 1N752A	CR3	1.000	03877	1N752A
0047	123072	RELAY 6PDT 24V 430 OHMS 5A@125VAC SILVER	K1	1.000		26-D-06C-18-C
0050	123171	HEATSINK TO-3 1.4X1.88X1.25H	XU5	1.000	30161	5016B
0053	102426	SCKT RELAY20 PIN & GND PC MT / 6FC	XK1	1.000	26806	ST 345-A2
0054	10242601	CLIP RETAINING AMER ZETTLER RLY AZ431-08-10L		1.000	26806	ST 345-1
0055	117324	SOCKT XSTRTO-220 .1C-C RTNG-BOARD	XU2,3,6	7.000	27264	10-18-2031
0055	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	XU7-10	.000		
0056	123172	CON PC RT ANGLE PIN 11 HDR .125C-C	J1	1.000	22526	65583-411
0057	123371	CON PC PIN1*12 HDR .125C-C .025SQ	J2	1.000	22526	65635-412
0058	123210	CON PC PIN 7 PIN MALE .125C-C	J5	1.000	22526	65635-407
0061	123176	CON RTNGLR 2PIN HDR W/FRICTION LOCK .1C-C	J3,4	2.000	27264	22-27-2021

REPLACEABLE PARTS LIST — Continued

Title: Power Supply PC Board Assembly A16, 07751001 (Figure 5-53) — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0063	10063204	PHMS CRES 6-32 X 1/4		2.000	96906	MS51957-26
0064	11965901	CON 1CCT PC PIN .110W .032TH .048D MTG BRSSN		1.000	79963	835
0065	10064406	PHMS CRES 10-32 X 3/8		4.000	96906	MS51958-61
0066	100705	FLAT WSHR 8 .187 ID.375 OD CRES		4.000	96906	MS15795-807
0067	100698	INT TOOTH #10 CRES		4.000	96906	MS35333-73
0068	123224	NUT SYNC BLIND 6-32 .166MTG		2.000	78187	8954-06-01
0070	119259	MASK SOLDRLATEX BASE PC FLEX HI-TEM	A/R	.000		#103

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Motherboard PC Board Assembly A17, 08325601 (Figure 5-55)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	083256	FAB PCB MOTHERBOARD		1.000	52542	
0002	2083256	ARTWORK PCB MOTHERBOARD	REF	.000	52542	
0004	123176	CON RTNGLR 2PIN HDR W/FRICTION LOCK .1C-C	J2	1.000	27264	22-27-2021
0005	117340	CON PC PIN2*13 HEADER .25SQ .1C-C	J1	1.000	30146	922584-26
0006	102806	CON PC EDG22 DUAL PC MT PESTR-GLASS		28.000	54453	ISM22DRKH-S50

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Feature 1 Timebase, 083514

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	08307502	OPT 01 HIGH STAB OSCILLATOR		1.000		
0003	08307501	ASSY PCB TCXO		1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: TCXO PC Board Assembly, 08307501

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	067921	TCMP XTLOS10MHZ 1E-6 0-70C 12/15V T	U1	1.000		
0002	083055	FAB OSC BRACKET		1.000	52542	
0003	083056	FAB OSC MTG PLATE		1.000	52542	
0004	100508	TERM SWAGEBIFUR .062MAT.24HI.093MTG		3.000	88245	1309B-1
0005	10062606	PHMS CRES 4-40 X 3/8		4.000	96906	MS51957-15
0006	100711	SPLIT LOCK#4 CRES		4.000	96906	MS35338-135
0007	102839	GLASS BEAD.100 OD X.045 IDX.060L		4.000		BY DESCRIPTION
0008	5083076	WIRE LIST		1.000	52542	
0009	100753	TIE CABLE 0-3/4 NAT NYLON 4IN L		1.000	96906	MS3367-4-9

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: High Stability Oscillator (Option 01), 08307502

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	99REF76	************ SEE ASSEMBLY DRAWING ***********		.000	52542	
0003	123651	XTLOS TSBL 10MHZ 5E-10/D 0-60C TTL OUT	A18	1.000	52542	
0007	10063206	PHMS CRES 6-32 X 3/8		4.000	96906	MS51957-28
0009	100712	SPLIT LOCK#6 CRES		4.000	96906	MS35338-136
0012	508307502	W/L,TSXO OPT 01		1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1501 Output Module Assembly (Standard), 07790101

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	07790301	ASSY DOUBLER MODULE	A22	1.000	52542	
0002	08303101	ASSY PCB DETECTOR/DRIVER	A23	1.000	52542	
0003	607790101	BLOCK DIAGRAM OUTPUT MODULE	REF	.000	52542	
0007	10063205	PHMS CRES 6-32 X 5/16		7.000	96906	MS51957-27
0009	100712	SPLIT LOCK#6 CRES		7.000	96906	MS35338-136
0010	100704	FLAT WSHR 6 .156 ID.312 OD CRES		7.000	96906	MS15795-805
0012	08309601	ASSY CABLE COAX SEMI-RIGID		1.000	52542	
0014	07793701	ASSY CABLE COAX S/RIGID		1.000	52542	
0016	07793504	ASSY FLAT RIBBON CABLE A22A13J1-A23A5J3		1.000	52542	
0018	08316001	ASSY EPROM PROG 150X LEVEL A22-23		1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 Output Module Assembly (Standard), 07790102

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	07790302	ASSY OUTPUT MODULE SECTION 2	A22	1.000	52542	
0002	08303102	ASSY OUTPUT MODULE SECTION 1	A23	1.000	52542	
0007	10063205	PHMS CRES 6-32 X 5/16		7.000	96906	MS51957-27
0009	100712	SPLIT LOCK#6 CRES		7.000	96906	MS35338-136
0010	100704	FLAT WSHR 6 .156 ID.312 OD CRES		7.000	96906	MS15795-805
0012	08309601	ASSY CABLE COAX SEMI-RIGID		1.000	52542	
0013	08310201	ASSY CABLE SEMI-RIGID		1.000	52542	
0014	07793701	ASSY CABLE COAX S/RIGID		1.000	52542	
0016	07793504	ASSY FLAT RIBBON CABLE A22A13J1-A23A5J3		1.000	52542	
0018	08316001	ASSY EPROM PROG 150X LEVEL A22-23		1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1501 Output Module Rear Panel Assembly (Option 02), 07790103

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	07790303	ASSY OUTPUT MODULE SECTION 2 REAR PANEL	A22	1.000	52542	
0002	08303101	ASSY PCB DETECTOR/DRIVER	A23	1.000	52542	
0003	607790101	BLOCK DIAGRAM OUTPUT MODULE	REF	.000	52542	
0007	10063205	PHMS CRES 6-32 X 5/16		7.000	96906	MS51957-27
0009	100712	SPLIT LOCK#6 CRES		7.000	96906	MS35338-136
0010	100704	FLAT WSHR 6 .156 ID.312 OD CRES		7.000	96906	MS15795-805
0012	08309601	ASSY CABLE COAX SEMI-RIGID		1.000	52542	
0014	07793702	ASSY,CABLE SR SMA A23A4J2-A22A12J1		1.000	52542	
0016	07793504	ASSY FLAT RIBBON CABLE A22A13J1-A23A5J3		1.000	52542	
0018	08316001	ASSY EPROM PROG 150X LEVEL A22-23		1.000	52542	
0020	103306	ADAPTER RFSMA RTANG PLUG/JACK		1.000	16733	705979

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 Output Module Rear Panel Assembly (Option 02), 07790104

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	07790304	ASSY OUTPUT MODULE SECTION 2 REAR PANEL	A22	1.000	52542	
0002	08303102	ASSY OUTPUT MODULE SECTION 1	A23	1.000	52542	
0007	10063205	PHMS CRES 6-32 X 5/16		7.000	96906	MS51957-27
0009	100712	SPLIT LOCK#6 CRES		7.000	96906	MS35338-136
0010	100704	FLAT WSHR 6 .156 ID.312 OD CRES		7.000	96906	MS15795-805
0012	08309601	ASSY CABLE COAX SEMI-RIGID		1.000	52542	
0013	08310201	ASSY CABLE SEMI-RIGID		1.000	52542	
0014	07793702	ASSY,CABLE SR SMA A23A4J2-A22A12J1		1.000	52542	
0016	07793504	ASSY FLAT RIBBON CABLE A22A13J1-A23A5J3		1.000	52542	
0018	08316001	ASSY EPROM PROG 150X LEVEL A22-23		1.000	52542	
0020	103306	ADAPTER RFSMA RTANG PLUG/JACK		1.000	16733	705979

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1501 Output Module Section 2 Assembly A22, 07790301 (Figure 5-57)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707790301	SCHEM DOUBLER MODULE	REF	.000	52542	
0007	08322601	ASSY PCB OUTPUT MODULE SECTION 2	A22A13	1.000	52542	
0008	077904	FAB BRACKET		1.000	52542	
0010	08317001	ASSY LEVELER/AMP .25-1.5 GHZ	A22A1	1.000	52542	
0013	10320307	ASSY LEVELER	A22A2	1.000	52542	
0020	123352	PRGM STEP ATTEN 0-130DB 10DB STEP DC-2500MHZ	A22A12	1.000	61162	50P-333
0021	07783201	ASSY CONNECTOR		1.000	52542	
0022	103306	ADAPTER RFSMA RTANG PLUG/JACK		1.000	16733	705979
0023	118770	TUBE SHRNK.13EXP .5L .06RCDWHT PLYO		8.000	06090	RNF100TYP1 1/8
0026	07792204	ASSY SWITCH HF SP2T	A22A3	1.000	52542	
0028	083082	FAB SPACER SWITCH		1.000	52542	
0040	10062505	PHMS CRES 2-56 X 5/16		4.000	96906	MS51957-4
0041	10062507	PHMS CRES 2-56 X 7/16		4.000	96906	MS51957-6
0050	100614	FLAT WSHR 2 .093 ID.250 OD CRES		8.000	96906	MS15795-802
0052	100661	SPLIT LOCK#2 CRES		8.000	96906	MS35337-77
0056	116076	NYLON WSHRSHLDR#6 .312 OD .188 MTG		8.000	86928	5607-68
0058	10063206	PHMS CRES 6-32 X 3/8		4.000	96906	MS51957-28
0059	10063205	PHMS CRES 6-32 X 5/16		2.000	96906	MS51957-27
0060	100704	FLAT WSHR 6 .156 ID.312 OD CRES		6.000	96906	MS15795-805
0062	100712	SPLIT LOCK#6 CRES		6.000	96906	MS35338-136

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 Output Module Section 2 Assembly A22, 07790302 (Figure 5-60)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707790302	SCH OUTPUT MODULE SECTION 2	REF	.000	52542	
0008	08317001	ASSY LEVELER/AMP .25-1.5 GHZ	A22A1	1.000	52542	
0009	10320307	ASSY LEVELER	A22A2	2.000	52542	
0009	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	A22A10	.000		
0010	07792203	ASSY SWITCH HF SP3T	A22A3	1.000	52542	
0011	123380	FREQ DBLR 50-1500MHZ @ INPUT SMA	A22A4	1.000	63155	XK-701S
0012	07791201	ASSY AMPLIFIER 2500 MHZ	A22A5	1.000	52542	
0013	07792201	ASSY SWITCH HF SP3T	A22A6	1.000	52542	
0014	123456	FILTER BANDPASS 1500-1900MHZ	A22A7	1.000		MT1804
0015	123457	FILTER BANDPASS 1900-2500 MHZ	A22A8	1.000		MT1805
0016	07792202	ASSY SWITCH HF SP3T	A22A9	1.000	52542	
0018	08345501	ASSY 2500 MHZ AMP +23DBM	A22A11	1.000	52542	
0019	123352	PRGM STEP ATTEN 0-130DB 10DB STEP DC-2500MHZ	A22A12	1.000	61162	50P-333
0020	08322601	ASSY PCB OUTPUT MODULE SECTION 2	A22A13	1.000	52542	
0022	07790601	ASSY CABLE COAX S/RIGID	W1	1.000	52542	
0024	07793903	ASSY,CABLE,SR SMA A22A9J1-A22A10J1	W2	1.000	52542	
0025	07783201	ASSY CONNECTOR		1.000	52542	
0026	077904	FAB BRACKET		1.000	52542	
0027	083082	FAB SPACER SWITCH	(A22A3)	1.000	52542	
0028	083083	FAB SPACER LEVLEER	(A22A10)	1.000	52542	
0029	103306	ADAPTER RFSMA RTANG PLUG/JACK		1.000	16733	705979
0030	118770	TUBE SHRNK.13EXP .5L .06RCDWHT PLYO		8.000	06090	RNF100TYP1 1/8
0031	107556	ADAPTER RFSMA PLUG TO SMA JACK		1.000	16179	2082-5133-02
0033	05542803	FXD ATTENR3DB DC/18GHZ SMA M&F .86L		1.000	52542	055428
0034	107556	ADAPTER RFSMA PLUG TO SMA JACK		.000	16179	2082-5133-02
0034	99REF74	**** ALTERNATE #1 FOR 07525301 (ITEM #25) ***	ITEM #33	.000		
0042	10062505	PHMS CRES 2-56 X 5/16		20.000	96906	MS51957-4
0043	10062507	PHMS CRES 2-56 X 7/16		4.000	96906	MS51957-6
0047	10062516	PHMS CRES 2-56 X 1 PHILLIPS		4.000		BY DESCRIPTION
0048	10062512	PHMS CRES 2-56 X 3/4		2.000	96906	MS51957-9
0050	100614	FLAT WSHR 2 .093 ID.250 OD CRES		36.000	96906	MS15795-802
0052	100661	SPLIT LOCK#2 CRES		30.000	96906	MS35337-77
0054	100636	NUT HEX 2-56 .19AF .06THK SS		6.000	96906	MS35649-224
0056	116076	NYLON WSHRSHLDR#6 .312 OD .188 MTG		8.000	86928	5607-68
0058	10063206	PHMS CRES 6-32 X 3/8		4.000	96906	MS51957-28
0059	10063205	PHMS CRES 6-32 X 5/16		2.000	96906	MS51957-27
0060	100704	FLAT WSHR 6 .156 ID.312 OD CRES		6.000	96906	MS15795-805
0062	100712	SPLIT LOCK#6 CRES		6.000	96906	MS35338-136

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1501 Output Module Section 2 Rear Panel Assembly A22 (Option 02), 07790303 (Figure 5-59)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707790301	SCHEM DOUBLER MODULE	REF	.000	52542	
0007	08322601	ASSY PCB OUTPUT MODULE SECTION 2	A22A13	1.000	52542	
0008	077904	FAB BRACKET		1.000	52542	
0010	08317001	ASSY LEVELER/AMP .25-1.5 GHZ	A22A1	1.000	52542	
0013	10320307	ASSY LEVELER	A22A2	1.000	52542	
0020	123352	PRGM STEP ATTEN 0-130DB 10DB STEP DC-2500MHZ	A22A12	1.000	61162	50P-333
0021	07783202	ASSY,CONN CABLE A22A12P1		1.000	52542	
0022	103306	ADAPTER RFSMA RTANG PLUG/JACK		1.000	16733	705979
0023	118770	TUBE SHRNK.13EXP .5L .06RCDWHT PLYO		8.000	06090	RNF100TYP1 1/8
0026	07792204	ASSY SWITCH HF SP2T	A22A3	1.000	52542	
0028	083082	FAB SPACER SWITCH		1.000	52542	
0040	10062505	PHMS CRES 2-56 X 5/16		4.000	96906	MS51957-4
0041	10062507	PHMS CRES 2-56 X 7/16		4.000	96906	MS51957-6
0050	100614	FLAT WSHR 2 .093 ID.250 OD CRES		8.000	96906	MS15795-802
0052	100661	SPLIT LOCK#2 CRES		8.000	96906	MS35337-77
0056	116076	NYLON WSHRSHLDR#6 .312 OD .188 MTG		8.000	86928	5607-68
0057	10073104	FHMS CRES 6-32 X 1/4		1.000	96906	MS24693-C24
0058	10063206	PHMS CRES 6-32 X 3/8		4.000	96906	MS51957-28
0059	10063205	PHMS CRES 6-32 X 5/16		1.000	96906	MS51957-27
0060	100704	FLAT WSHR 6 .156 ID.312 OD CRES		5.000	96906	MS15795-805
0062	100712	SPLIT LOCK#6 CRES		5.000	96906	MS35338-136

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 Output Module Section 2 Rear Panel Assembly A22 (Option 02), 07790304 (Figure 5-62)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707790302	SCH OUTPUT MODULE SECTION 2	REF	.000	52542	
0008	08317001	ASSY LEVELER/AMP .25-1.5 GHZ	A22A1	1.000	52542	
0009	10320307	ASSY LEVELER	A22A2	2.000	52542	
0009	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	A22A10	.000		
0010	07792203	ASSY SWITCH HF SP3T	A22A3	1.000	52542	
0011	123380	FREQ DBLR 50-1500MHZ @ INPUT SMA	A22A4	1.000	63155	XK-701S
0012	07791201	ASSY AMPLIFIER 2500 MHZ	A22A5	1.000	52542	
0013	07792201	ASSY SWITCH HF SP3T	A22A6	1.000	52542	
0014	123456	FILTER BANDPASS 1500-1900MHZ	A22A7	1.000		MT1804
0015	123457	FILTER BANDPASS 1900-2500 MHZ	A22A8	1.000		MT1805
0016	07792202	ASSY SWITCH HF SP3T	A22A9	1.000	52542	
0018	08345501	ASSY 2500 MHZ AMP +23DBM	A22A11	1.000	52542	
0019	123352	PRGM STEP ATTEN 0-130DB 10DB STEP DC-2500MHZ	A22A12	1.000	61162	50P-333
0020	08322601	ASSY PCB OUTPUT MODULE SECTION 2	A22A13	1.000	52542	
0022	07790601	ASSY CABLE COAX S/RIGID	W1	1.000	52542	
0024	07793903	ASSY,CABLE,SR SMA A22A9J1-A22A10J1	W2	1.000	52542	
0025	07783202	ASSY,CONN CABLE A22A12P1		1.000	52542	
0026	077904	FAB BRACKET		1.000	52542	
0027	083082	FAB SPACER SWITCH		1.000	52542	
0028	083083	FAB SPACER LEVLEER		1.000	52542	
0028	107556	ADAPTER RFSMA PLUG TO SMA JACK		1.000	16179	2082-5133-02
0029	103306	ADAPTER RFSMA RTANG PLUG/JACK		1.000	16733	705979
0030	118770	TUBE SHRNK.13EXP .5L .06RCDWHT PLYO		8.000	06090	RNF100TYP1 1/8
0033	05542803	FXD ATTENR3DB DC/18GHZ SMA M&F .86L		1.000	52542	055428
0034	107556	ADAPTER RFSMA PLUG TO SMA JACK		.000	16179	2082-5133-02
0034	99REF74	**** ALTERNATE #1 FOR 07525301 (ITEM #25) ***	ITEM #33	.000		
0042	10062505	PHMS CRES 2-56 X 5/16		20.000	96906	MS51957-4
0043	10062507	PHMS CRES 2-56 X 7/16		4.000	96906	MS51957-6
0047	10062516	PHMS CRES 2-56 X 1 PHILLIPS		4.000		BY DESCRIPTION
0048	10062512	PHMS CRES 2-56 X 3/4		2.000	96906	MS51957-9
0050	100614	FLAT WSHR 2 .093 ID.250 OD CRES		35.000	96906	MS15795-802
0052	100661	DIODE PIN 100V .3P	R1	1.000	0112	BB2205
0023	101737	RES CC 1/4W 75 OHMS 5%		00	96733	SG133BX103MP
0026	103348	50V 18DB@10MHZ 65DB@100MHZ	J4 R3			
0039	07382601	LABEL MODEL		3.000	01121	BB2405
0023	101697	RE40 THREAD	FT1,2	2.000	31	103692 WIRE,MAGNT#38 POLY NYL

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Leveler/Amplifier Assembly A22A1, 08317001

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	708317001	SCH LEVELER/AMP .25-1.5 GHZ	REF	.000	52542	
0006	083169	FAB HOUSING		1.000	52542	
0008	083171	FAB COVER LEVELER/AMP		1.000	52542	
0010	083172	FAB WALL		1.000	52542	
0012	083170	FAB PCB		1.000	52542	
0014	2083170	ARTOWRK PCB	REF	.000	52542	
0016	123650	IC LIN AMP 2.0GHZ@1DBPT 8.5DB 13DBM@1DB UXPAC	U1,2	2.000	25539	MSA-0435
0018	123416	DIODE PIN 100V .3PF@50V R1.5@.1A 24R920@100N	CR1-6	6.000	54987	AL-67003-15
0020	101324	INDUCT FXD.33UH 10% 30QMIN .10X.25	L1-4	4.000	06560	4416-7K
0022	101706	RES CC 1/8W 22 OHMA 5%	R1	1.000	0112	BB2205
0023	101737	RES CC 1/4W 75 OHMS 5%	R2	1.000	01121	CB7505
0024	100300	CAP C CHIP220PF 20%100V.09L.065W.05	C1-7	7.000	96773	SB133BX221MP
0025	106509	CAP C CHIP.01UF 50V 20% X7R <.095L*	C8	1.000	96733	SG133BX103MP
0026	103348	RECEPT RF SMA THRD MT JACK HERMETIC GOLD	J1,2	2.000	16179	2058-5119-00
0028	103362	RECEPT RF SMB JACK FRMT SNAP <.28PR	J3	1.000	98291	51-045-0000
0030	123531	FILTER RFI 10A 50V 18DB@10MHZ 65DB@100MHZ	J4	1.000	33095	51-712-069
0032	103996	FILHMS 0-80X.125 SLOTTED		8.000	04264	CS104S OR=
0036	10070003	FHMS CRES 2-56 X 3/16		4.000	80205	NAS662C2R3
0039	07382601	LABEL MODEL/SERIAL/PART		1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Leveler Assembly A22A2, 10320307

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	7010320307	SCH LEVELER	REF	.000	52542	
0005	077721	HOUSING PIN SWITCH		1.000	52542	
0007	077719	FAB COVER PIN SW HOUSING		1.000	52542	
0009	083229	FAB SUBSTRATE PIN LEVELER		1.000	52542	
0011	2083229	ARTWORK SUBSTRATE PIN LEVELER	REF	.000	52542	
0013	083092	FAB LABEL LEVELER		1.000	52542	
0017	10070004	FHMS CRES 2-56 X 1/4		6.000	80205	NAS662C2R4
0019	11993101	CAP C CHIP 150PF 10% 100V .018W.03L.008H AU	C1-4	4.000		CSA140-18X30X8-G15AK
0021	123251	DIODE PIN R<3@30MA C<.025PF BMLD TL100NS TR20	CR1-4	4.000	52542	
0023	103993	RES CHIP 51 5% 35MW@25C .035*.035	R1	1.000	50316	MSR10G-510J
0025	116994	INDUCTOR 100NH SOL.018D*.032L R.7	L1,2	2.000		20-1847-CAT
0027	103348	RECEPT RF SMA THRD MT JACK HERMETIC GOLD	J1	1.000	16179	2058-5119-00
0029	116582	RECEPT RF SMA THRD MT JACK MALE	J2	1.000	16733	705970-004
0031	05583901	CONNECTOR MODIFICATION SMC	J3	1.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 2500-MHz Amplifier Assembly A22A11, 08345501

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0002	07382601	LABEL MODEL/SERIAL/PART		1.000	52542	
0003	708345501	SCH 2500 MHZ AMP +23DBM	REF	.000	52542	
0004	083695	FAB HOUSING AMP		1.000	52542	
0005	077914	FAB COVER		1.000	52542	
0006	10070004	FHMS CRES 2-56 X 1/4		4.000	80205	NAS662C2R4
0007	10890303	SOCHDCAPSC 0-80 X 3/16 CRES		2.000	STNDRD	MS16996-2
0008	101017	LUG SOLDER.120MTG.50L 1HOLE.072DIA		2.000	79963	75-.120
0009	2083455	A/W SUBSTRATE 2500 MHZ AMP	REF	.000	52542	
0010	083455	FAB SUBSTRATE 2500 MHZ AMP		1.000	52542	
0011	123771	RTIDUROID 5880 .015 THICK W/1/2 OX ELECTRO CU	REF	.000		DUROID 5880 .015 THI
0012	123499	GAASFET NCH HMF-601 2-18GHZ 10V	Q1,2	2.000		HMF-0601
0013	123784	GDAS FET HMF-0602 2-14GHZ 250MW 8DB PKG20	Q3	1.000		HMF-0602
0014	720440	DIODE SGNLIN4148 75V	CR1	1.000		IN4148 (GLASS)
0015	100378	DIODE ZENR 5.1V .4W 5% 1N751A	CR3	1.000	03877	1N751A
0016	102873	DIODE ZENR 10V 1W @ 50CA 5% 1N4740A	CR2	1.000	*****	1N4740A
0018	123777	CHIP CAP 500PF +/- 20% 50V	C5-11	7.000		GH065C501MA
0019	123778	CHIP CAP 500PF +/- 20% 50V	C1-4	4.000		GH035C501MA
0021	123790	RES CHIP 200 OHM 125MW .050X030X015 +- 200PPM	R1,2	2.000		RP0503BS-2000JN-01
0022	101809	RES CC 1/8W 24 OHMS 5%	R3-5	3.000	01121	BB2405
0023	101697	RES CC 1/8W 10K 5%	R6	1.000	01121	BB1035
0025	116994	INDUCTOR 100NH SOL.018D*.032L R.7	L1-4	4.000		20-1847-CAT
0027	123789	FILTER RFI 5A 100V 10DB@1MHZ 4-40 THREAD	FT1,2	2.000		SCI-3112-002
0028	100711	SPLIT LOCK#4 CRES		2.000	96906	MS35338-135
0029	103348	RECEPT RF SMA THRD MT JACK HERMETIC GOLD	J1,2	2.000	16179	2058-5119-00
0031	103692	WIRE,MAGNT#38 POLY NYLON 130C HEAVY	L5,6	.045		DESCR
0031	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	(.540IN)	.000		
0033	083090	FAB CLAMPING BLOCK	REF	.000	52542	

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Output Module Section 2 PC Board Assembly A22A13, 08322601

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0002	707790301	SCHEM DOUBLER MODULE	REF	.000	52542	
0004	2083226	A/W PCB OUTPUT MOD SECTION 2	REF	.000	52542	
0006	083226	FAB PCB OUTPUT MODULE SECTION 2		1.000	52542	
0008	11964701	CON PC PIN 2*13 RTANG HDR.1C-C W/LOCKS	J1	1.000	75037	3429-1203
0010	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L1-3	3.000	02114	VK200-20/4B
0012	100575	TERM PRESSFDTH .086MTG .06MAT .515L		4.000	98921	001-1007
0014	100510	SPCR SWAGE6-32 .25L X.25RND .09MAT		7.000	05704	73-3
0015	101569	RES CC 1/4W 1.0K 5%	R1	1.000	01121	CB1025
0016	101584	RES CC 1/4W 5.6K 5%	R2	1.000	01121	CB5625

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1501 Output Module Section 1 Assembly A23, 08303101 (Figure 5-63)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	708303101	SCHEM DETECTOR/DRIVER	REF	.000	52542	
0002	08342801	ASSY FILTER/AMP	A23A1	1.000	52542	
0003	07792601	ASSY DETECTOR	A23A4	1.000	52542	
0005	07792901	ASSY SWITCH LF SP3T	A23A3	1.000	52542	
0009	07792501	ASSY PCB A23	A23A5	1.000	52542	
0010	116609	FLAT WSHR 2 .093ID .156OD .03TH CRE		8.000	86928	5710-6-30
0011	100661	SPLIT LOCK#2 CRES		8.000	96906	MS35337-77
0012	10062504	PHMS CRES 2-56 X 1/4		8.000	96906	MS51957-3
0014	100807	ADHESIVE 1CMPNT FINE THRD >750PSI	A/R	.000	76381	88-21

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 Output Module Section 1 Assembly A23, 08303102 (Figure 5-65)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	708303102	SCH OUTPUT MOD SECTION 1	REF	.000	52542	
0002	08342802	ASSY FILTER/AMP	A23A1	1.000	52542	
0003	07792601	ASSY DETECTOR	A23A4	1.000	52542	
0005	07792902	ASSY SWITCH LF SP3T PROP	A23A3	1.000	52542	
0009	07792501	ASSY PCB A23	A23A5	1.000	52542	
0010	116609	FLAT WSHR 2 .093ID .156OD .03TH CRE		8.000	86928	5710-6-30
0011	100661	SPLIT LOCK#2 CRES		8.000	96906	MS35337-77
0012	10062504	PHMS CRES 2-56 X 1/4		8.000	96906	MS51957-3
0014	100807	ADHESIVE 1CMPNT FINE THRD >750PSI	A/R	.000	76381	88-21

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1501 Filter/Amplifier Assembly A23A1, 08342801

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	708342801	SCH FILTER/AMP	REF	.000	52542	
0003	083425	FAB HOUSING FILTER/AMP		1.000	52542	
0005	083426	FAB COVER		1.000	52542	
0007	2083428	ARTWORK SUBSTRATE	REF	.000	52542	
0009	083428	FAB SUBSTRATE		1.000	52542	
0013	117391	RES CHIP 330 5% 35MW .035SQ .012TH	R1,2	2.000	50316	MSR10G-331J
0019	101551	RES CC 1/2W 180 OHMS 5%	R3	1.000	01121	EB1815
0023	100300	CAP C CHIP220PF 20%100V.09L.065W.05	C1,14,	6.000	96773	SB133BX221MP
0023	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	15-18	.000		
0025	123022	CAP C CHIP 2.1PF +/-0.1PF 50V	C2	1.000	29990	ATC100A2R1BPX
0026	123013	CAP C CHIP 9.1PF +/-5% 50V	C3	1.000	29990	ATC100A9R1JPX
0027	123023	CAP C CHIP 12PF +/-5% 50V	C4	1.000	29990	ATC100A120JPX
0029	123731	CAP C CHIP 4.7PF +-.25PF 50V	C5	1.000	29990	ATC100A4R7CPX
0031	123732	CAP C CHIP 8.2PF +- 25PF 50V	C6,7	2.000	29990	ATC100A8R2CPX
0033	123016	CAP C CHIP 2.7PF +/-0.1PF 50V	C8	1.000	29990	ATC100A2R7BPX
0035	123733	CAP C CHIP 5.6PF +-.25PF 50V	C9,10	2.000	29990	ATC100A5R6CPX
0037	123021	CAP C CHIP 1.7PF +/-0.1PF 50V	C11	1.000	29990	ATC100A1R7BPX
0039	123019	CAP C CHIP 3.6PF +/-0.1PF 50V	C12,13	2.000	29990	ATC100A3R6BPX
0043	123024	CAP C CHIP 6.8PF +/-5% 50V	C19	1.000	29990	ATC100A6R8JPX
0044	123025	CAP C CHIP 6.2PF +/-0.25PF 50V	C20	1.000	29990	ATC100A6R2CPX
0045	116994	INDUCTOR 100NH SOL.018D*.032L R.7	L1-4	4.000		20-1847-CAT
0047	123008	INDUCT FXD 21.8NH	L5	1.000	52542	
0049	123006	INDUCT FXD 6.0NH	L6,7	2.000	52542	
0051	123009	INDUCT FXD 14.0NH	L10	1.000	52542	
0053	123007	INDUCT FXD 4.17NH	L8	1.000	52542	
0057	123650	IC LIN AMP 2.0GHZ@1DBPT 8.5DB 13DBM@1DB UXPAC	U1	1.000	25539	MSA-0435
0059	123028	AMP RF CASCADABLE 10-1500MHZ A<8DB <20DBM@1DB	U2	1.000	14482	WJ-A29-1
0063	123531	FILTER RFI 10A 50V 18DB@10MHZ 65DB@100MHZ	J2-5,11	5.000	33095	51-712-069
0066	103348	RECEPT RF SMA THRD MT JACK HERMETIC GOLD	J1,6,10	3.000	16179	2058-5119-00
0069	103362	RECEPT RF SMB JACK FRMT SNAP <.28PR	J9	1.000	98291	51-045-0000
0071	075315	RECEPT RF SMB JACK FRMT SNAP <.28PR	(J7,8)	2.000		

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 Filter/Amplifier Assembly A23A1, 08342802

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	708342802	SCH FILTER/AMP	REF	.000	52542	
0003	083425	FAB HOUSING FILTER/AMP		1.000	52542	
0005	083426	FAB COVER		1.000	52542	
0007	2083428	ARTWORK SUBSTRATE	REF	.000	52542	
0009	083428	FAB SUBSTRATE		1.000	52542	
0013	117391	RES CHIP 330 5% 35MW .035SQ .012TH	R1,2	2.000	50316	MSR10G-331J
0019	101551	RES CC 1/2W 180 OHMS 5%	R3	1.000	01121	EB1815
0023	100300	CAP C CHIP220PF 20%100V.09L.065W.05	C1,14,	6.000	96773	SB133BX221MP
0023	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C15-18	.000		
0025	123022	CAP C CHIP 2.1PF +/-0.1PF 50V	C2	1.000	29990	ATC100A2R1BPX
0026	123013	CAP C CHIP 9.1PF +/-5% 50V	C3	1.000	29990	ATC100A9R1JPX
0027	123023	CAP C CHIP 12PF +/-5% 50V	C4	1.000	29990	ATC100A120JPX
0029	123731	CAP C CHIP 4.7PF +-.25PF 50V	C5	1.000	29990	ATC100A4R7CPX
0031	123732	CAP C CHIP 8.2PF +- 25PF 50V	C6,7	2.000	29990	ATC100A8R2CPX
0033	123016	CAP C CHIP 2.7PF +/-0.1PF 50V	C8	1.000	29990	ATC100A2R7BPX
0035	123733	CAP C CHIP 5.6PF +-.25PF 50V	C9,10	2.000	29990	ATC100A5R6CPX
0037	123021	CAP C CHIP 1.7PF +/-0.1PF 50V	C11	1.000	29990	ATC100A1R7BPX
0039	123019	CAP C CHIP 3.6PF +/-0.1PF 50V	C12,13	2.000	29990	ATC100A3R6BPX
0043	123024	CAP C CHIP 6.8PF +/-5% 50V	C19	1.000	29990	ATC100A6R8JPX
0044	123025	CAP C CHIP 6.2PF +/-0.25PF 50V	C20	1.000	29990	ATC100A6R2CPX
0045	116994	INDUCTOR 100NH SOL.018D*.032L R.7	L1-4	4.000		20-1847-CAT
0047	123008	INDUCT FXD 21.8NH	L5	1.000	52542	
0049	123006	INDUCT FXD 6.0NH	L6,7	2.000	52542	
0051	123009	INDUCT FXD 14.0NH	L10	1.000	52542	
0053	123007	INDUCT FXD 4.17NH	L8	1.000	52542	
0057	123650	IC LIN AMP 2.0GHZ@1DBPT 8.5DB 13DBM@1DB UXPAC	U1	1.000	25539	MSA-0435
0059	123028	AMP RF CASCADABLE 10-1500MHZ A<8DB <20DBM@1DB	U2	1.000	14482	WJ-A29-1
0063	123531	FILTER RFI 10A 50V 18DB@10MHZ 65DB@100MHZ	J2-5,11	5.000	33095	51-712-069
0066	103348	RECEPT RF SMA THRD MT JACK HERMETIC GOLD	J1,6,7,8	5.000	16179	2058-5119-00
0066	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	J10	.000		
0069	103362	RECEPT RF SMB JACK FRMT SNAP <.28PR	J9	1.000	98291	51-045-0000

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 Detector Assembly A23A4, 07792601

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0004	707792601	SCHEM ASSY DETECTOR	REF	.000	52542	
0006	077881	FAB HOUSING		1.000	52542	
0007	077882	FAB COVER		1.000	52542	
0008	10070003	FHMS CRES 2-56 X 3/16		4.000	80205	NAS662C2R3
0009	10062503	PHMS CRES 2-56 X 3/16		4.000	96906	MS51957-2
0011	077926	FAB SUBSTRATE DETECTOR		1.000	52542	
0012	2077926	ARTWORK SUBSTRATE DETECTOR	REF	.000	52542	
0014	123427	DIODE DET MX2277 SCHOTTKY .5PF VBR<8V@10MA	CR1,2	2.000		MX2277
0015	100315	CAP C CHIP47PF 100V5%.100LX.065WNPO	C3,4	2.000	96773	SB133BY470JP
0016	123525	CAP C CHIP 47PF 50V 5% 3700+-1000 PPM/C	C1,2	2.000	55153	D35NU470J5PX
0017	123466	CAP C CHIP .056UF 50V 10% X7R .095L .07W .05T	C5,6	2.000	95275	VJ0905Y563KFA
0018	100300	CAP C CHIP220PF 20%100V.09L.065W.05	C7	1.000	96773	SB133BX221MP
0019	100263	CAP C CHIP22PF 5% 50V NPO<.06W*.11L	C8	1.000	32159	SG92BY220JP
0020	117757	RES MF 1.00K .1W 1% 100PPM <.28	R1,2	2.000		C=RN55D1001F
0021	103998	RES CHIP 22 5% 75MW@70C 200PPM .05	R3	1.000	34420	1C220J
0022	123734	RES CHIP 18 5% .5W .052W .110L	R4,5	2.000	50316	WA9PG-180J-S
0023	103348	RECEPT RF SMA THRD MT JACK HERMETIC GOLD	J1,2	2.000	16179	2058-5119-00
0024	108880	TERM INS 4-40THRD FDTH .156HEX X .6L TEFLON	J3,4	2.000	71279	570-2643-010119
0025	07382601	LABEL MODEL/SERIAL/PART		1.000	52542	
0026	117362	RES CHIP 100 10% .13W .05W*.1L	R3,R6	2.000	50316	4328

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 PC Board Assembly A23A5, 07792501

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	708303101	SCHEM DETECTOR/DRIVER	REF	.000	52542	
0002	2077925	ARTWORK PCB DETECTOR/DRIVER	REF	.000	52542	
0003	077925	FAB PCB A23		1.000	52542	
0004	100176	CAP CER DP 1UF 50V 20% Z5U .38LS	C1,3,4,6	19.000	56289	2C37Z5U105M050B
0004	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	C31-34,	.000		
0004	99REF02	************* REF DESN'TORS CONT *************	48-52,56	.000		
0004	99REF03	************* REF DESN'TORS CONT *************	57,59,61	.000		
0004	99REF04	************* REF DESN'TORS CONT *************	64,65	.000		
0010	117570	CAP CER DP .01 UF 100V 20% X7R	C2,5,	21.000	04222	SR201C103MAA
0010	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	7-12,	.000		
0010	99REF02	************* REF DESN'TORS CONT *************	17-22,	.000		
0010	99REF03	************* REF DESN'TORS CONT *************	26-29,47	.000		
0010	99REF04	************* REF DESN'TORS CONT *************	53,54,	.000		
0016	100063	CAP TANT 10UF 20V 10%	C36,46	2.000	56289	150D106X9020B2
0018	11228101	CAP TANT 22UF 25V 20% RDLD@.25	C37-40	6.000		TAPB22M25
0018	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	58,60	.000		
0019	116619	CAP C DP .047UF 10%/.056UF 20% 100V X7R .1LS	C62	1.000	51642	200-100-X7R563M
0020	117569	CAP CER DP4700PF 100V 20% X7R <.2SQ	C63	1.000	04222	3418100C472M
0021	117621	CAP CER DP10PF 100V 5% COG .1LS <.1	C66	1.000	96733	DB44BY100J
0024	100385	DIODE SGN1N4151 50V	CR1-3,	21.000	03508	1N4151
0024	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	8-24,26	.000		
0027	100390	DIODE ZENR 12V .4W 5% 1N963B	CR4	1.000	04713	1N963B
0028	100440	DIODE SGNL1N4830 20V 2.69V FWD	CR5,25	2.000	03508	1N4830
0030	100442	DIODE SIGL HP-2800 70V 100PS ULTRA FAST SW	CR27,28	2.000	28480	5082-2800
0032	106673	INDUCT FXD3.6UH 850 OHMS .240X.395	L1-4	4.000	02114	VK200-20/4B
0034	101302	INDUCT FXD270UH 5% 52QMIN .16X.45	L5,6	2.000	00213	WEE-270
0036	101409	JFET NCHNL2N4091 40V R<30 -10VP-5V	Q5	1.000	04713	2N4091
0038	101377	XSTR SI NPN 2N3904 40V 100B300@10 MA	Q6,10	2.000	04713	2N3904
0040	101378	XSTR SI PNP 2N3906 40V 100B300@10MA TO-92	Q9	1.000	04713	2N3906
0042	101570	RES CC 1/4W 10K 5%	R1-4	11.000	01121	CB1035
0042	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	11-17,	.000		
0043	101574	RES CC 1/4W 47K 5%	R27,80	2.000	01121	CB4735
0046	101558	RES CC 1/4W 100K 5%	R5,6	2.000	01121	CB1045
0048	101607	RES CC 1/4W 20K 5%	R7-10,18	9.000	01121	CB2035
0048	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	26,28,83	.000		
0048	99REF02	************* REF DESN'TORS CONT *************	84	.000		
0053	101670	RES CC 1/4W 56K 5%	R19	1.000	01121	CB5635
0055	101609	RES CC 1/4W 100 OHMS 5%	R20-25	7.000	01121	CB1015
0055	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	36	.000		
0058	101630	RES CC 1/4W 470K 5%	R29	1.000	01121	CB4745
0060	101569	RES CC 1/4W 1.0K 5%	R30	1.000	01121	CB1025
0062	101717	RES CC 1/4W 120 OHMS 5%	R33,34	2.000	01121	CB1215
0064	101672	RES CC 1/4W 51 OHMS 5%	R35,37	2.000	01121	CB5105
0066	112284	RES CC 1/4W 1.0 OHMS 10%	R39	1.000		WC025K
0068	101995	RES CC 1/4W 5.6 OHMS 5%	R40	1.000	01121	CB56G5
0070	101566	RES CC 1/4W 220 OHMS 5%	R42	1.000	01121	CB2215

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 PC Board Assembly A23A5, 07792501 — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0072	101598	RES CC 1/4W 4.7K 5%	R43,86	3.000	01121	CB4725
0073	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	R87	.000		
0074	101498	RES CC 1/2W 100 OHMS 5%	R44-50	7.000	01121	EB1015
0076	117758	RES MF 150 .1W 1% 100PPM Z.28L*	R51	1.000		C=RN55D1500F
0078	103194	RES MF 806 1% .12W@125C 100PPM	R52	1.000	91637	CMF-60 T1
0080	101731	RES CC 1/4W 33 OHMS 5%	R53-55	4.000	01121	CB3305
0080	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	85	.000		
0082	101577	RES CC 1/4W 1.5K 5%	R57,58	2.000	01121	CB1525
0084	118997	RES MF 3.92K .1W 1% 25PPM/C <.14	R59	1.000	91637	CMF-55 T9
0086	102228	RES MF 442 .12W 1% 100PPM	R60	1.000	91637	MFF-1/8 T1
0088	123139	RES MF 100 .1W 1% 25PPM/C <.14D * .281L	R61	1.000	91637	CMF-55 T9
0090	119128	RES MF 68.1K .1W 1% 25PPM/C <.14	R62	1.000	91637	CMF-55 T9
0094	119008	RES MF 4.99K .1W 1% 25PPM/C <.14	R64,65	2.000	91637	CMF-55 T9
0096	117585	RES MF 10.0K .1 W 1% 100PPM .28L	R66-70	8.000		C=RN55D1002F
0096	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	73,94,95	.000		
0100	102473	POT 15T PC 5K 10% 3/8W CERM ENDADJ	R71,77,	2.000	73138	89PR5K
0102	101579	RES CC 1/4W 18K 5%		1.000	01121	CB1835
0104	101557	RES CC 1/4W 10 OHMS 5%	R74	1.000	01121	CB1005
0106	101536	RES CC 1/4W 330 OHMS 5%	R75	1.000	01121	CB3315
0107	117576	RES MF 4.99K .1W 1% 100PPM <.28	R76	1.000		C=RN55D4991F
0108	119049	RES MF 12.4K .1W 1% 25PPM/C <.14		1.000	91637	CMF-55 T9
0112	101548	RES CC 1/4W 3.0K 5%	R81,82	2.000	01121	CB3025
0118	102286	RES MF 61.9K .1 W 1% 50PPM	R89,90	2.000		RN55C6192F
0120	101599	RES CC 1/4W 2.7K 5%	R91	1.000	01121	CB2725
0122	101625	RES CC 1/4W 470 OHMS 5%	R92,93	2.000	01121	CB4715
0123	102472	POT 15T PC 10K 10% 3/8W CERM ENDADJ	R97	1.000	73138	89PR10K
0125	045008	RES MODULE4-12K .1W 20% COMP CARBON	RN1-3	3.000	52542	MRG-C-5Y-12K-K
0133	123003	IC LIN MPQ3904 QUAD NPN XSTR 40V	U1,3,7	3.000	04713	MPQ3904
0135	123206	IC LIN MPQ3906 QUAD PNP XSTR 40V	U2,4-6	4.000	04713	MPQ3906
0137	123408	IC LIN MPQ6002 QUAD NPN XSTR 25V	U8	1.000	04713	MPQ6002
0139	11886801	IC VOLTREF AD581JH 10.00V +-30MV 30PPM/C	U9	1.000	24335	AD581JH
0141	117703	IC OP AMP TL072 2JFET A68DB 10UV/C	U10,12,	3.000	01295	TL072CP
0141	99REF01	**** REF DESN'TORS CONT FROM ABOVE **********	13	.000		
0144	118870	IC VOLTREGLM317T 37-2V@1.5A TO-220	U11	1.000	27014	LM317T
0146	119975	IC OP AMP 5532 DUAL LOW NOISE	U14,15	2.000	18324	NE5532AN
0148	07793503	ASSY CABLE FLAT RIBBON	J1	1.000	52542	
0149	07793502	ASSY CABLE FLAT RIBBON	J2	1.000	52542	
0150	117340	CON PC PIN2*13 HEADER .25SQ .1C-C	J3	1.000	30146	922584-26
0151	103173	RECEPT RF RTANG JACK SMB PCMT SNAP	J5	1.000	98291	51-053-0000
0152	11972401	CON PC PIN 11 STR HDR .1C-C	J4	1.000	27264	22-03-2111
0153	100978	HEATSINK .15MT .71W1.0L.50H 25C/W		1.000	98978	PA1-1CB
0154	103397	NYLON WSHRSHLD TO-220 MOT199-04		1.000	02735	DF137A
0155	100941	NUT KEP 4-40 .281OD .11THK CPS		1.000	78189	511-041800-00
0156	10062607	PHMS CRES 4-40 X 7/16		1.000	96906	MS51957-16
0158	100703	FLAT WSHR #4 .125 ID.250 OD CRES		2.000	96906	MS15795-803
0159	103352	INS XISTORTO-220 .61/.48W.75/.69L>.		1.000	08289	SK-73-48-13

REPLACEABLE PARTS LIST — Continued

Title: Model 1502 PC Board Assembly A23A5, 07792501 — Continued

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0161	101096	SPCR SWAGE6-32 1.25L X.25HEX .06MAT		7.000	06540	9640B-B-0632-3A
0162	101117	MYLAR WSHR.225ID .363OD .007THK		1.000	86928	5622-26-7

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Power Distribution PC Board Assembly A24, 07794401 (Figure 5-67)

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0001	707751001	SCHEM PCB POWER SUPPLY	REF	.000	52542	
0003	507778101	WIRE LIST ASSY PCB POWER DISTRIB		1.000	52542	
0005	077944	FAB PCB POWER DISTRIBUTION		1.000	52542	
0006	2077944	ARTWORK PCB POWER DISTRIBUTION	REF	.000	52542	
0007	123055	CAP EL CAN20000UF 20V 1.75D*3.125L LOW POST	C1,2,11	3.000		EMC203BG20S
0008	101476	RES CC 1/2W 390 OHMS 5%	R24	1.000	01121	EB3915
0009	101485	RES CC 1/2W 270 OHMS 5%	R25	1.000	01121	EB2715
0010	11965901	CON 1CCT PC PIN .110W .032TH .048D MTG BRSSN		2.000	79963	835
0041	11964701	CON PC PIN 2*13 RTANG HDR.1C-C W/LOCKS	J1	1.000	75037	3429-1203
0050	10064406	PHMS CRES 10-32 X 3/8		6.000	96906	MS51958-61
0051	100705	FLAT WSHR 8 .187 ID.375 OD CRES		6.000	96906	MS15795-807
0052	100698	INT TOOTH #10 CRES		6.000	96906	MS35333-73

** LIST END **

REPLACEABLE PARTS LIST — Continued

Title: Power Supply Plate Assembly, 07776601

ITEM NUMBER	SD PART NUMBER	COMPONENT DESCRIPTION	REFERENCE DESIGNATOR	TOTAL QTY	CAGE (FSCM)	MANUFACTURER'S PART NUMBER
0009	707751001	SCHEM PCB POWER SUPPLY	REF	.000	52542	
0010	077766	FAB POWER SUPPLY PLATE		1.000	52542	
0020	119218	DIODE RECTMDA2504 400V 25A BRIDGE	U11-14	4.000	04713	MDA2504
0022	119989	IC VOLTREG LM337T -1.2 TO -37V 1.5A TO-220	U2,7,8	3.000	27041	LM337T
0024	118870	IC VOLTREGLM317T 37-2V@1.5A TO-220	U3,6,9	3.000	27014	LM317T
0028	103039	IC VOLTREG7815 15V 5%,1A,15W-.5W/C@	U10	1.000	04713	MC7815CT
0030	103352	INS XISTORTO-220 .61/.48W.75/.69L>.		7.000	08289	SK-73-48-13
0032	100750	THERML COMPOUND FOR MTG XISTORS & DIODES	A/R	.000	05820	120-8
0034	10062605	PHMS CRES 4-40 X 5/16		7.000	96906	MS51957-14
0036	100711	SPLIT LOCK#4 CRES		7.000	96906	MS35338-135
0038	100703	FLAT WSHR #4 .125 ID.250 OD CRES		7.000	96906	MS15795-803
0040	103397	NYLON WSHRSHLD TO-220 MOT199-04		7.000	02735	DF137A
0042	10064212	PHMS CRES 8-32 X 3/4		4.000	96906	MS51957-47
0044	100705	FLAT WSHR 8 .187 ID.375 OD CRES		4.000	96906	MS15795-807
0046	100713	SPLIT LOCK#8 CRES		4.000	96906	MS35338-137

** LIST END **

CHAPTER 5

DRAWINGS

5-1. INTRODUCTION

5-1.1. This chapter contains the assembly and schematic diagrams for the 1500 Series Microwave Synthesizers. The parts list in Chapter 4 relates to the reference designation callouts on the diagrams. Table 5-1 provides a list by figure number of the drawings with title, drawing number, revision level, and page number.

Table 5-1. List of Drawings

Figure Number	Drawing Title	Drawing Number	Page Number
5-1	1500 Series Simplified Block Diagram (Sheet 1 of 2)		5-5
	1500 Series Simplified Block Diagram (Sheet 2 of 2)		5-6
5-2	1500 Series Block Wiring Diagram (Sheet 1 of 2)	6077511	5-7
	1500 Series Block Wiring Diagram (Sheet 2 of 2)	6077511	5-8
5-3	1500 Series Universal Assembly	08350801	5-9
5-4	Chassis Assembly (Sheet 1 of 2)	07728401	5-11
	Chassis Assembly (Sheet 2 of 2)	07728401	5-12
5-5	Printed Circuit (PC) Enclosure (Sheet 1 of 2)	08326401	5-13
	Printed Circuit (PC) Enclosure (Sheet 2 of 2)	08326401	5-14
5-6	Front Panel Assembly	07730901	5-15
5-7	Rear Panel Assembly	07729201	5-16
5-8	Bottom Cover Assembly	07742701	5-17
5-9	Keyboard and Display A1 and Front Panel Interface A2 Block Diagram	607766001	5-19
5-10	Keyboard and Display PC Board Assembly A1	07766001	5-20
5-11	Front Panel Interface PC Board Assembly A2	07766101	5-21
5-12	Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 1 of 8)	707766101	5-22
	Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 2 of 8)	707766101	5-23
	Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 3 of 8)	707766101	5-24
	Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 4 of 8)	707766101	5-25

Table 5-1. List of Drawings — Continued

Figure Number	Drawing Title	Drawing Number	Page Number
	Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 5 of 8)	707766101	5-26
	Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 6 of 8)	707766101	5-27
	Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 7 of 8)	707766101	5-28
	Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 8 of 8)	707766101	5-29
5-13	Interface A3 Block Diagram	607760001	5-31
5-14	Interface PC Board Assembly A3	07760001	5-32
5-15	Interface A3 Schematic	707760001	5-33
5-16	Level Control A4 Block Diagram	607762001	5-35
5-17	Level Control PC Board Assembly A4	07762001	5-36
5-18	Level Control A4 Schematic	707762001	5-37
5-19	Audio Synthesizer A5 Block Diagram	607736701	5-39
5-20	AM Audio Synthesizer PC Board Assembly A5A	07736703	5-40
5-21	FM Audio Synthesizer PC Board Assembly A5B	07736704	5-41
5-22	Audio Synthesizer A5 Schematic (Sheet 1 of 2)	7077367TAB	5-42
	Audio Synthesizer A5 Schematic (Sheet 2 of 2)	7077367TAB	5-43
5-23	Downconverter A6 Block Diagram	607734301	5-44
5-24	Downconverter PC Board Assembly A6	07734301	5-45
5-25	Downconverter A6 Schematic (Sheet 1 of 2)	707734301	5-46
	Downconverter A6 Schematic (Sheet 2 of 2)	707734301	5-47
5-26	Loop 1 A7 Block Diagram	607752101	5-48
5-27	Loop 1 Output PC Board Assembly A7	07752101	5-49
5-28	Loop 1 A7 Schematic (Sheet 1 of 2)	707752101	5-50
	Loop 1 A7 Schematic (Sheet 2 of 2)	707752101	5-51

Table 5-1. List of Drawings — Continued

Figure Number	Drawing Title	Drawing Number	Page Number
5-29	Loop 1 IF A8 Block Diagram (Sheet 1 of 2)	607735301	5-52
	Loop 1 IF A8 Block Diagram (Sheet 2 of 2)	607735301	5-53
5-30	Loop 1 IF PC Board Assembly A8	07735301	5-55
5-31	Loop 1 IF A8 Schematic (Sheet 1 of 2)	707735301	5-56
	Loop 1 IF A8 Schematic (Sheet 2 of 2)	707735301	5-57
5-32	Loops 2 and 9 A9 Block Diagram (Sheet 1 of 2)	607760201	5-58
	Loops 2 and 9 A9 Block Diagram (Sheet 2 of 2)	607760201	5-59
5-33	Loops 2 and 9 PC Board Assembly A9	07760201	5-61
5-34	Loops 2 and 9 A9 Schematic (Sheet 1 of 2)	707760201	5-62
	Loops 2 and 9 A9 Schematic (Sheet 2 of 2)	707760201	5-63
5-35	Loops 3 and 4 A10 Block Diagram	607749301	5-64
5-36	Loops 3 and 4 PC Board Assembly A10	07749301	5-65
5-37	Loops 3 and 4 A10 Schematic (Sheet 1 of 2)	707749301	5-66
	Loops 3 and 4 A10 Schematic (Sheet 2 of 2)	707749301	5-67
5-38	Divide-by-N and Divide-by-P A11 Block Diagram	607753201	5-69
5-39	Divide-by-N and Divide-by-P PC Board Assembly A11	07753201	5-70
5-40	Divide-by-N and Divide-by-P A11 Schematic	707753201	5-71
5-41	Divide-by-Q A12 Block Diagram	607751501	5-73
5-42	Divide-by-Q PC Board Assembly A12	07751501	5-74
5-43	Divide-by-Q A12 Schematic	707751501	5-75
5-44	Loops 5, 6, and 7 A13 Block Diagram	607754201	5-77
5-45	Loops 5, 6, and 7 PC Board Assembly A13	07754201	5-78
5-46	Loops 5, 6, and 7 A13 Schematic (Sheet 1 of 3)	707754201	5-79
	Loops 5, 6, and 7 A13 Schematic (Sheet 2 of 3)	707754201	5-80
	Loops 5, 6, and 7 A13 Schematic (Sheet 3 of 3)	707754201	5-81

Table 5-1. List of Drawings — Continued

Figure Number	Drawing Title	Drawing Number	Page Number
5-47	Reference Frequency Generator A14 Block Diagram	607743401	5-82
5-48	Reference Frequency Generator PC Board Assembly A14	07743401	5-83
5-49	Reference Frequency Generator A14 Schematic (Sheet 1 of 2)	707743401	5-84
	Reference Frequency Generator A14 Schematic (Sheet 2 of 2)	707743401	5-85
5-50	CPU A15 Block Diagram	607733101	5-87
5-51	CPU PC Board Assembly A15	07733101	5-88
5-52	CPU A15 Schematic	707733101	5-89
5-53	Power Supply PC Board Assembly A16	07751001	5-90
5-54	Power Supply A16 Schematic	707751001	5-91
5-55	Motherboard PC Board Assembly A17	08325601	5-92
5-56	Output Module A22/A23 Block Diagram	607790101	5-93
5-57	Model 1501 Output Module Section 2 Assembly A22	07790301	5-94
5-58	Model 1501 Output Module Section 2 A22 Schematic	707790301	5-95
5-59	Model 1501 Output Module Section 2 Rear Panel Assembly A22 (Option 02)	07790303	5-97
5-60	Model 1502 Output Module Section 2 Assembly A22	07790302	5-98
5-61	Model 1502 Output Module Section 2 A22 Schematic	707790302	5-99
5-62	Model 1502 Output Module Section 2 Rear Panel Assembly A22 (Option 02)	07790304	5-100
5-63	Model 1501 Output Module Section 1 Assembly A23	08303101	5-101
5-64	Model 1501 Output Module Section 1 A23 Schematic (Sheet 1 of 2)	708303101	5-102
	Model 1501 Output Module Section 1 A23 Schematic (Sheet 2 of 2)	708303101	5-103
5-65	Model 1502 Output Module Section 1 Assembly A23	08303102	5-105
5-66	Model 1502 Output Module Section 1 A23 Schematic (Sheet 1 of 2)	708303102	5-106
	Model 1502 Output Module Section 1 A23 Schematic (Sheet 2 of 2)	708303102	5-107
5-67	Power Distribution PC Board Assembly A24	07794401	5-108

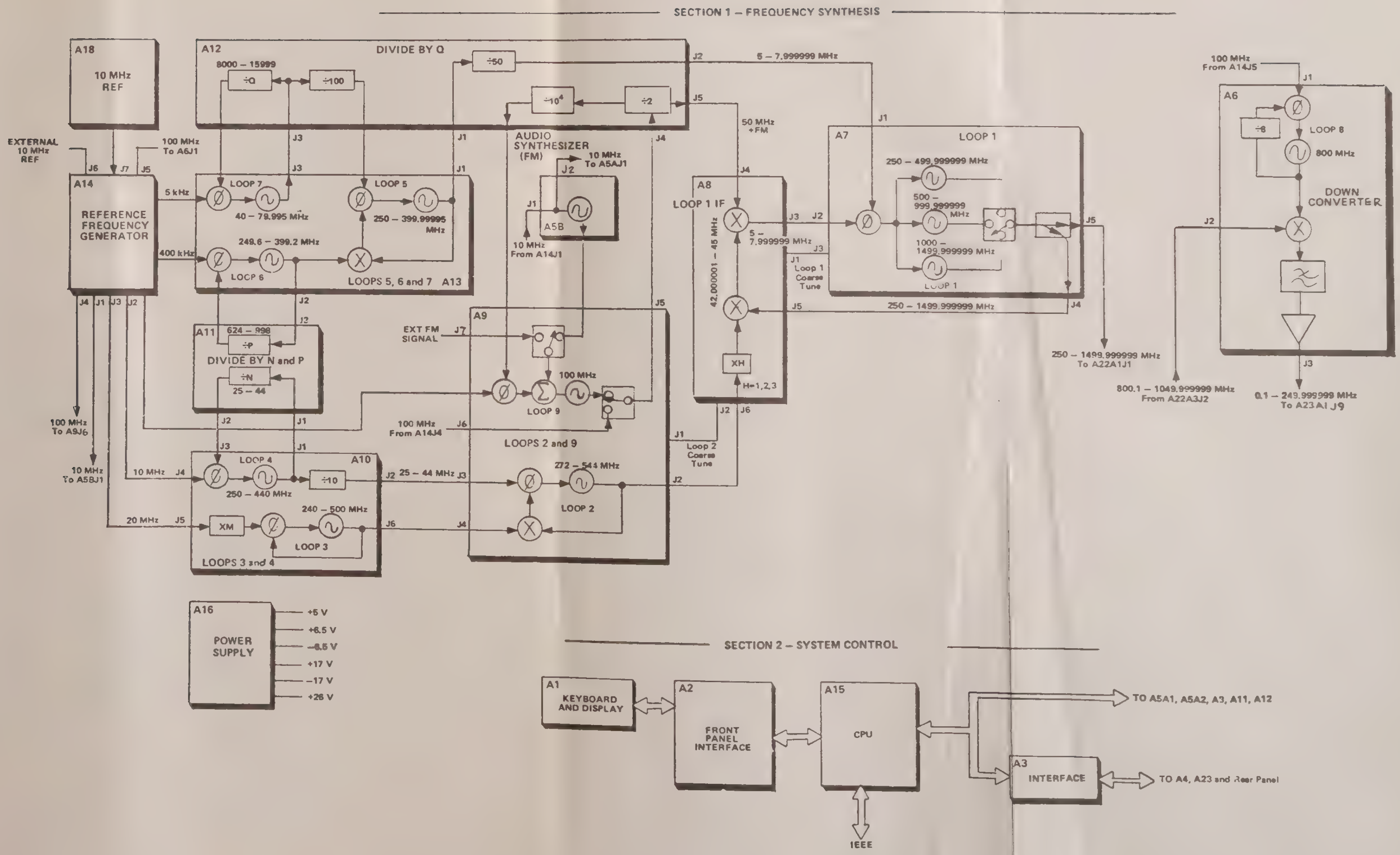

SECTION 1 – FREQUENCY SYNTHESIS
A18
10 MHz REF
EXTERNAL 10 MHz REF
100 MHz To A6J1
J6
J7
J5
A14
REFERENCE FREQUENCY GENERATOR
5 kHz
400 kHz
J4
J1
J3
J2
100 MHz To A9J6
10 MHz To A5BJ1
A12
DIVIDE BY Q
8000 – 15999
÷Q
÷100
÷50
÷10^4
÷2
J2
5 – 7.999999 MHz
J5
J3
J1
J4
LOOP 7
40 – 79.995 MHz
LOOP 5
250 – 399.99995 MHz
249.6 – 399.2 MHz
LOOP 6
LOOPS 5, 6 and 7
A13
A11
624 – 998
÷P
DIVIDE BY N and P
÷N
25 – 44
J2
J1
J3
A10
10 MHz
J4
LOOP 4
250 – 440 MHz
÷10
J2
25 – 44 MHz
J3
20 MHz
J5
XM
240 – 500 MHz
LOOP 3
J6
LOOPS 3 and 4
AUDIO SYNTHESIZER (FM)
J2
10 MHz To A5AJ1
J1
A5B
10 MHz From A14J1
EXT FM SIGNAL
J7
A9
100 MHz
LOOP 9
100 MHz From A14J4
J6
LOOPS 2 and 9
272 – 544 MHz
LOOP 2
J4
J2
J5
J1
Loop 2 Coarse Tune
50 MHz +FM
A8
LOOP 1 IF
42.000001 – 45 MHz
5 – 7.999999 MHz
J3
J1
Loop 1 Coarse Tune
XH
H=1,2,3
J2
J6
A7
LOOP 1
J1
250 – 499.999999 MHz
500 – 999.999999 MHz
1000 – 1499.999999 MHz
LOOP 1
J2
J3
J5
J4
250 – 1499.999999 MHz
250 – 1499.999999 MHz To A22A1J1
100 MHz From A14J5
J1
A6
÷8
LOOP 8
800 MHz
DOWN CONVERTER
J2
J3
800.1 – 1049.999999 MHz From A22A3J2
0.1 – 249.999999 MHz To A23A1 J9
A16
POWER SUPPLY
+5 V
+6.5 V
–6.5 V
+17 V
–17 V
+26 V
SECTION 2 – SYSTEM CONTROL
A1
KEYBOARD AND DISPLAY
A2
FRONT PANEL INTERFACE
A15
CPU
IEEE
TO A5A1, A5A2, A3, A11, A12
A3
INTERFACE
TO A4, A23 and Rear Panel

Figure 5-1. 1500 Series Simplified Block Diagram (Sheet 1 of 2)

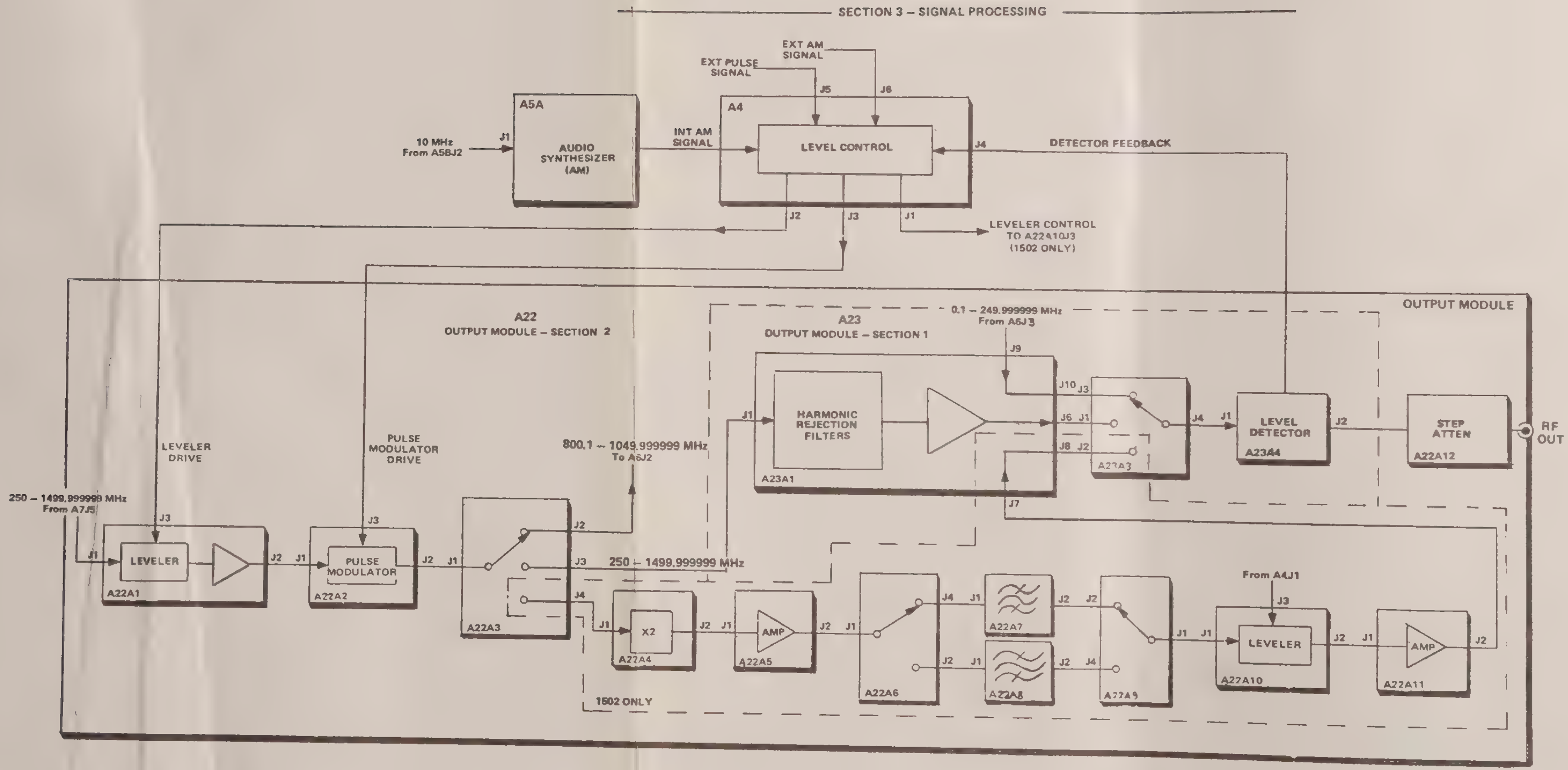
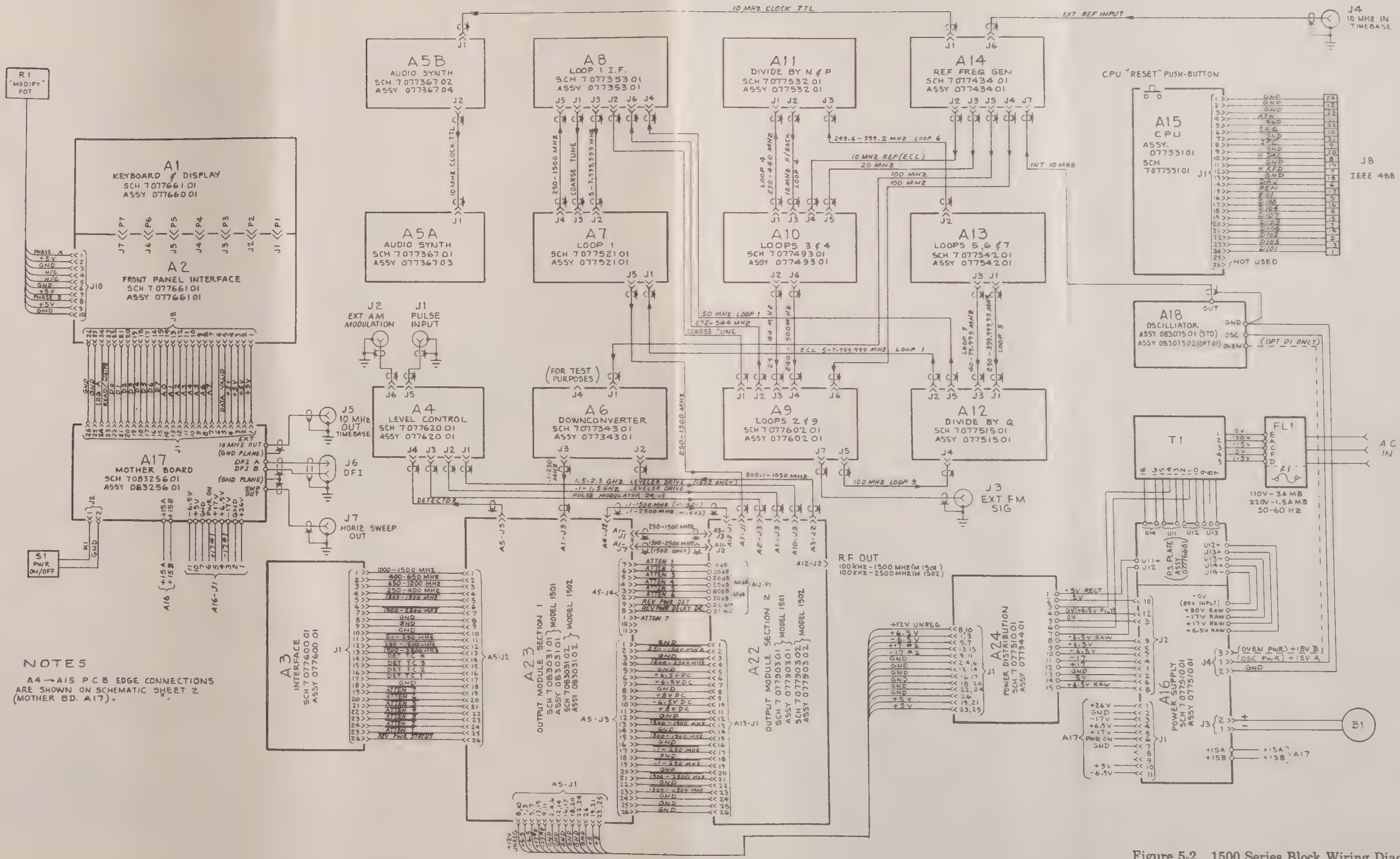

SECTION 3 – SIGNAL PROCESSING
EXT AM SIGNAL
EXT PULSE SIGNAL
J5
J6
A5A
10 MHz From A5BJ2
J1
AUDIO SYNTHESIZER (AM)
INT AM SIGNAL
A4
LEVEL CONTROL
J4
DETECTOR FEEDBACK
J2
J3
J1
LEVELER CONTROL TO A22A10J3 (1502 ONLY)
OUTPUT MODULE
A22
OUTPUT MODULE – SECTION 2
A23
OUTPUT MODULE – SECTION 1
0.1 – 249.999999 MHz From A6J3
J9
LEVELER DRIVE
PULSE MODULATOR DRIVE
800.1 – 1049.999999 MHz To A6J2
250 – 1499.999999 MHz From A7J5
J1
J3
LEVELER
J2
A22A1
J1
J3
PULSE MODULATOR
J2
A22A2
J1
J2
J3
J4
A22A3
250 – 1499.999999 MHz
J1
HARMONIC REJECTION FILTERS
A23A1
J10
J6
J8
J7
J3
J1
J2
J4
A23A3
J1
LEVEL DETECTOR
A23A4
J2
STEP ATTEN
A22A12
RF OUT
J1
X2
J2
A22A4
J1
AMP
J2
A22A5
J1
J4
J2
A22A6
J1
J2
A22A7
J1
J2
A22A8
J2
J4
J1
A22A9
From A4J1
J3
J1
LEVELER
J2
A22A10
J1
AMP
J2
A22A11
1502 ONLY

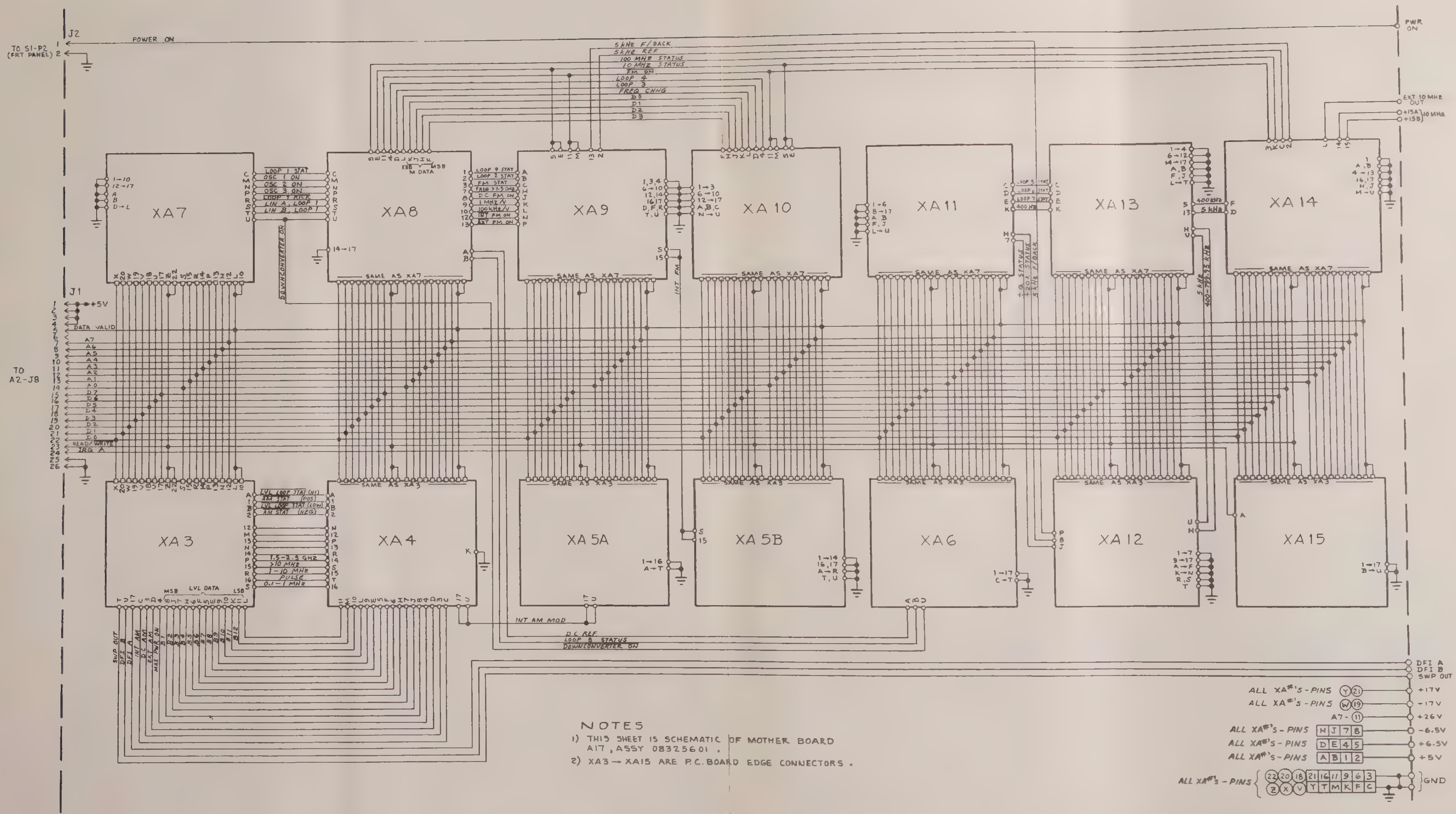
Figure 5-1. 1500 Series Simplified Block Diagram (Sheet 2 of 2)


10 MHz CLOCK TTL
EXT REF INPUT
J4 10 MHz IN TIMEBASE
R1 "MODIFY" POT
A5B AUDIO SYNTH SCH 7 077367 02 ASSY 077367 04
A8 LOOP 1 I.F. SCH 7 077353 01 ASSY 077353 01
A11 DIVIDE BY N & P SCH 7 077532 01 ASSY 077532 01
A14 REF FREQ GEN SCH 7 077434 01 ASSY 077434 01
CPU "RESET" PUSH-BUTTON
A15 CPU ASSY. 077331 01 SCH 7 077331 01
J8 IEEE 488
NOT USED
10 MHz CLOCK TTL
250-1500 MHz
COARSE TUNE
5-7.999,999 MHz
249.6-399.2 MHz LOOP 6
10 MHz REF (ECL)
20 MHz
100 MHz
100 MHz
INT 10 MHz
LOOP 4 250-440 MHz
10 MHz F/BACK
LOOP 4
A1 KEYBOARD & DISPLAY SCH 7 077661 01 ASSY 077660 01
A2 FRONT PANEL INTERFACE SCH 7 077661 01 ASSY 077661 01
A5A AUDIO SYNTH SCH 7 077367 01 ASSY 077367 03
A7 LOOP 1 SCH 7 077521 01 ASSY 077521 01
A10 LOOPS 3 & 4 SCH 7 077493 01 ASSY 077493 01
A13 LOOPS 5, 6 & 7 SCH 7 077542 01 ASSY 077542 01
PHASE A
+5V
GND
N/C
N/C
GND
+5V
PHASE B
+5V
GND
J10
50 MHz LOOP 1
272-544 MHz
COARSE TUNE
ECL 5-7.999,999 MHz LOOP 1
44 MHz
500 MHz
LOOP 7 40-79.995 MHz
250-399.999,95 MHz LOOP 5
A18 OSCILLATOR ASSY 083075 01 (STD) ASSY 083075 02 (OPT 01)
OUT
GND
OSC
OVEN
(OPT 01 ONLY)
J2 EXT AM MODULATION
J1 PULSE INPUT
(FOR TEST PURPOSES)
A4 LEVEL CONTROL SCH 7 077620 01 ASSY 077620 01
A6 DOWNCONVERTER SCH 7 077343 01 ASSY 077343 01
A9 LOOPS 2 & 9 SCH 7 077602 01 ASSY 077602 01
A12 DIVIDE BY Q SCH 7 077515 01 ASSY 077515 01
T1
FL1
AC IN
110V-3A MB 220V-1.5A MB 50-60 Hz
J5 10 MHz OUT TIMEBASE
J6 DFI
J7 HORIZ SWEEP OUT
A17 MOTHER BOARD SCH 7 083256 01 ASSY 083256 01
EXT 10 MHz OUT
(GND PLANE)
DFI A
DFI B
(GND PLANE)
SWP OUT
1.5-2.5 GHz LEVELER DRIVE (1502 ONLY)
.1-1.5 GHz LEVELER DRIVE
PULSE MODULATOR DRIVE
DETECTOR
800.1-1050 MHz
100 MHz LOOP 9
J3 EXT FM SIG
250-1500 MHz
.1-250 MHz
.1-1500 MHz (M 1501)
.1-2500 MHz (M 1502)
1500-2500 MHz (1502 ONLY)
RF OUT 100 kHz-1500 MHz (M 1501) 100 kHz-2500 MHz (M 1502)
S1 PWR ON/OFF
K1
GND
+15A +15B
A16
A16-J1
A3 INTERFACE SCH 7 077600 01 ASSY 077600 01
1000-1500 MHz
400-650 MHz
650-1000 MHz
250-400 MHz
1800-1900 MHz
1900-2500 MHz
GND
0.1-250 MHz
250-500 MHz
1500-2500 MHz
DET TC 4
DET TC 3
DET TC 2
DET TC 1
ATTEN 6
ATTEN 5
ATTEN 4
ATTEN 3
ATTEN 2
ATTEN 1
REV PWR STATUS
A5-J2
A23 OUTPUT MODULE SECTION 1 SCH 7 083031 01 ASSY 083031 01 } MODEL 1501 SCH 7 083031 02 ASSY 083031 02 } MODEL 1502
A5-J4
A5-J3
ATTEN 1
ATTEN 2
ATTEN 3
ATTEN 4
ATTEN 5
ATTEN 6
REV PWR DET
REV PWR DELAY DC
ATTEN 7
0 dB
20 dB
20 dB
20 dB
10 dB
30 dB
DC O/P
S1 N/C
A12-P1
+6.5VDC
+8VDC
-6.5VDC
A22 OUTPUT MODULE SECTION 2 SCH 7 077903 01 ASSY 077903 01 } MODEL 1501 SCH 7 077903 02 ASSY 077903 02 } MODEL 1502
A13-J1
A5-J1
+12V UNREG
+6.5V
-6.5V
+17 #2
-17 #2
+5V
A24 POWER DISTRIBUTION SCH 7 077510 01 ASSY 077534 01
+5V RECT
5V
0V (+6.5V FILT)
0V
-6.5V RAW
+6.5V
-6.5V
+17
-17
5V
+6.5V RAW
U14 U11 U12 U13
P.S. PLATE ASSY 077660
U11+
U12
U12+
U13+
U13-
U14+
U14-
-0V (80V INPUT)
+80V RAW
-17V RAW
+17V RAW
+6.5V RAW
(OVEN PWR) +15V B
(OSC PWR) +15V A
GND
A16 POWER SUPPLY SCH 7 077510 01 ASSY 077510 01
+26V
GND
-17V
+6.5V
+17V
PWR ON
GND
+5V
-6.5V
A17
+15A
+15B
B1

NOTES

A4→A15 PCB EDGE CONNECTIONS ARE SHOWN ON SCHEMATIC SHEET 2 (MOTHER BD. A17).

Figure 5-2. 1500 Series Block Wiring Diagram (Sheet 1 of 2)

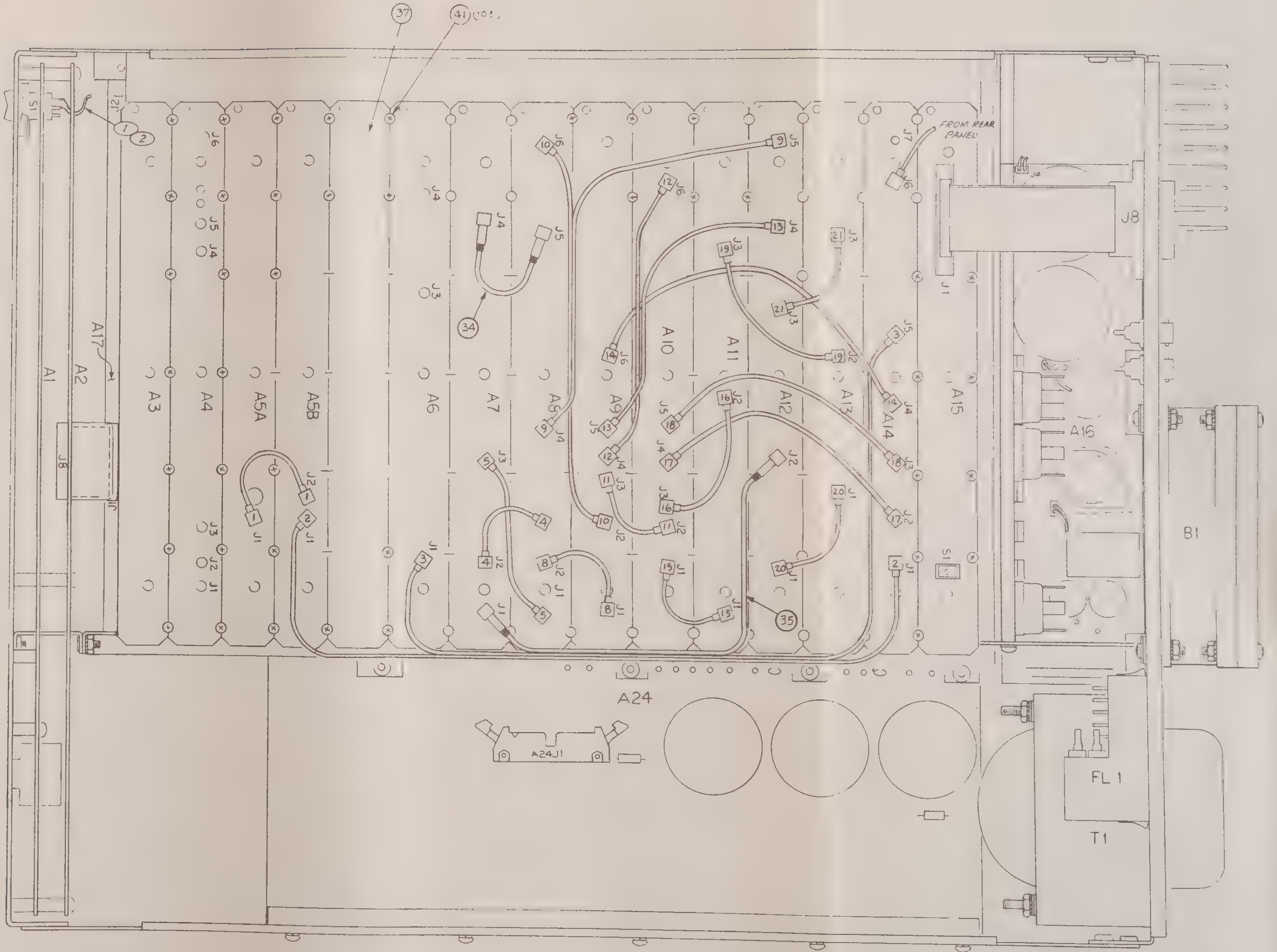

J2
TO S1-P2 (FRT PANEL)
POWER ON
PWR ON
EXT 10 MHz OUT
+15A
+15B
10 MHz
5 kHz F/BACK
5 kHz REF
100 MHz STATUS
10 MHz STATUS
FM ON
LOOP 4
LOOP 3
FREQ CHNG
D0
D1
D2
D3
XA7
XA8
XA9
XA 10
XA 11
XA13
XA 14
XA3
XA4
XA 5A
XA 5B
XA6
XA 12
XA15
LOOP 1 STAT
OSC 1 ON
OSC 2 ON
OSC 3 ON
LOOP 7 KICK
LIN A, LOOP 1
LIN B, LOOP 1
M DATA
LSB
MSB
LOOP 9 STAT
LOOP 2 STAT
FM STAT
FREQ > 1.5 GHz
DC FM ON
1 MHz/N
100kHz/N
INT FM ON
EXT FM ON
DOWNCONVERTER ON
INT FM
SAME AS XA7
SAME AS XA3
LOOP 5 STAT
LOOP 6 STAT
LOOP 7 STAT
400 kHz
5 kHz
+8 STATUS
+20 STATUS
5 kHz F/BACK
5 kHz
400-799.95 kHz
J1
+5V
DATA VALID
A7
A6
A5
A4
A3
A2
A1
A0
D7
D6
D5
D4
D3
D2
D1
D0
READ/WRITE
IRQ A
TO A2-J8
LVL LOOP STAT (HI)
XA3 STAT (POS)
LVL LOOP STAT (LOW)
AM STAT (NEG)
1.5-2.5 GHz
>10 MHz
1-10 MHz
PULSE
0.1-1 MHz
LVL DATA
INT AM MOD
DC REF
LOOP 8 STATUS
DOWNCONVERTER ON
SWP OUT
DFI B
DFI A
INT AM
EXT AM
MAX PWR ON
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
DFI A
DFI B
SWP OUT
ALL XA#'S-PINS Y 21 +17V
ALL XA#'S-PINS W 19 -17V
A7- 11 +26V
ALL XA#'S-PINS H J 7 8 -6.5V
ALL XA#'S-PINS D E 4 5 +6.5V
ALL XA#'S-PINS A B 1 2 +5V
ALL XA#'S-PINS 22 20 18 21 16 11 9 6 3 Z X V Y T M K F C GND

NOTES

1) THIS SHEET IS SCHEMATIC OF MOTHER BOARD A17, ASSY 08325601.

2) XA3 → XA15 ARE P.C. BOARD EDGE CONNECTORS.

Figure 5-2. 1500 Series Block Wiring Diagram (Sheet 2 of 2)


37
41
FROM REAR PANEL
1
2
34
35
A1
A2
A17
A3
A4
A5A
A5B
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
A16
J8
S1
B1
A24
A24J1
FL 1
T1

COAX KIT 08351301 CABLING CONNECTIONS				
CABLE NUMBER	PART NUMBER	FROM	TO	APPROX LENGTH
1	083657 01	A5A - J1	A5B - J2	2"
2	083657 06	A5B - J1	A14 - J1	6"
3	083657 06	A6 - J1	A14 - J5	6"
4	083657 01	A7 - J2	A8 - J3	2
5	083657 02	A7 - J3	A8 - J1	3 1/4"
6				
7				
8	083657 01	A8 - J2	A9 - J1	2"
9	083657 04	A8 - J4	A12 - J5	7 1/2"
10	083657 04	A8 - J6	A9 - J2	7 1/2"
11	083657 01	A9 - J3	A10 - J2	2"
12	083657 03	A9 - J4	A10 - J6	5 1/4"
13	083657 03	A9 - J5	A12 - J4	5 1/4"
14	083657 04	A9 - J6	A14 - J4	7 1/2"
15	083657 01	A10 - J1	A11 - J1	2"
16	083657 02	A10 - J3	A11 - J2	3 1/4
17	083657 03	A10 - J4	A14 - J2	5 1/4"
18	083657 03	A10 - J5	A14 - J3	5 1/4"
19	083657 02	A11 - J3	A13 - J2	3 1/4"
20	083657 01	A12 - J1	A13 - J1	2"
21	083657 01	A12 - J3	A13 - J3	2"

NOTES:

1. ○ REF. W/L 507730901, FRONT PANEL

Figure 5-3. 1500 Series Universal Assembly

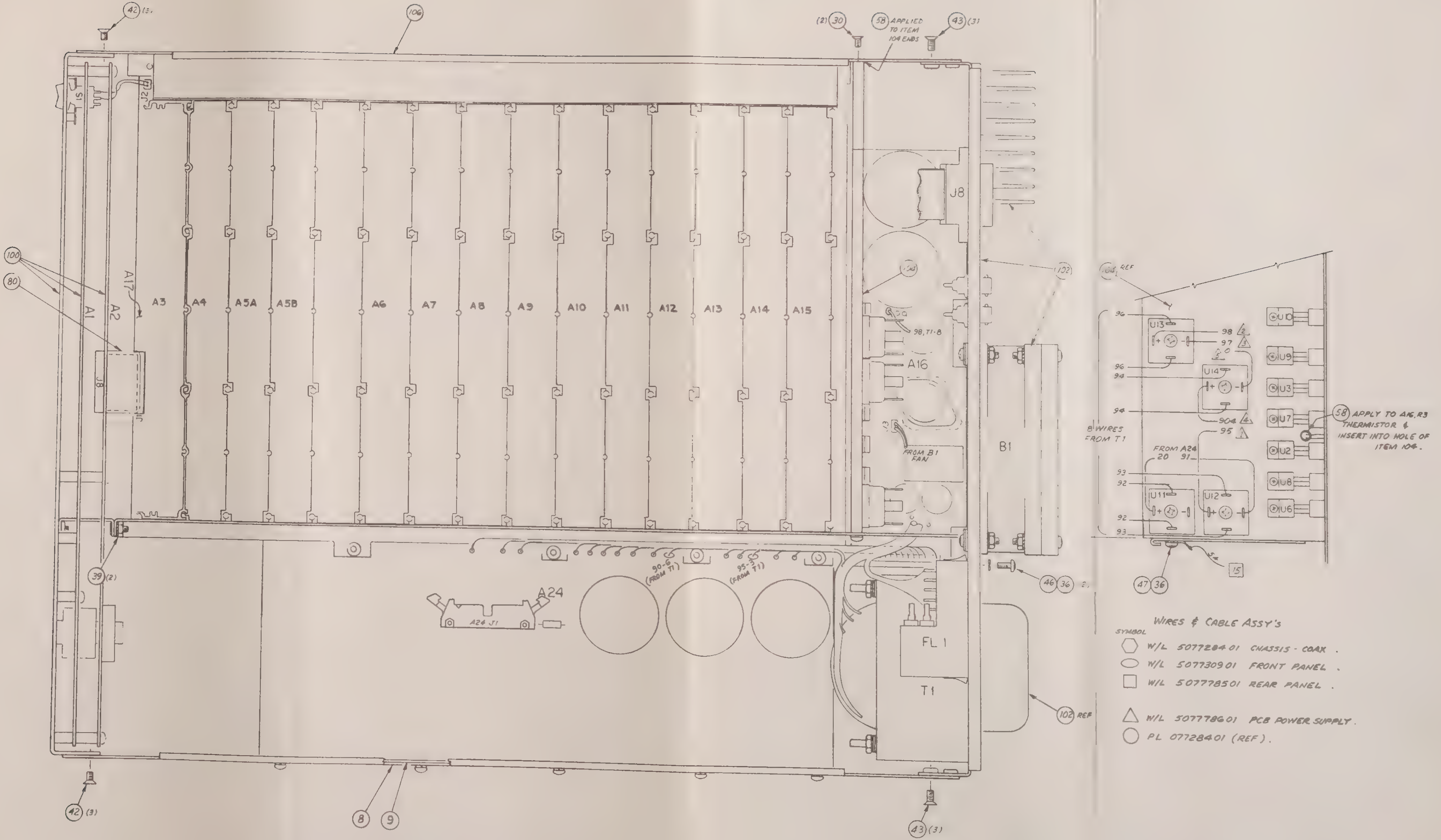
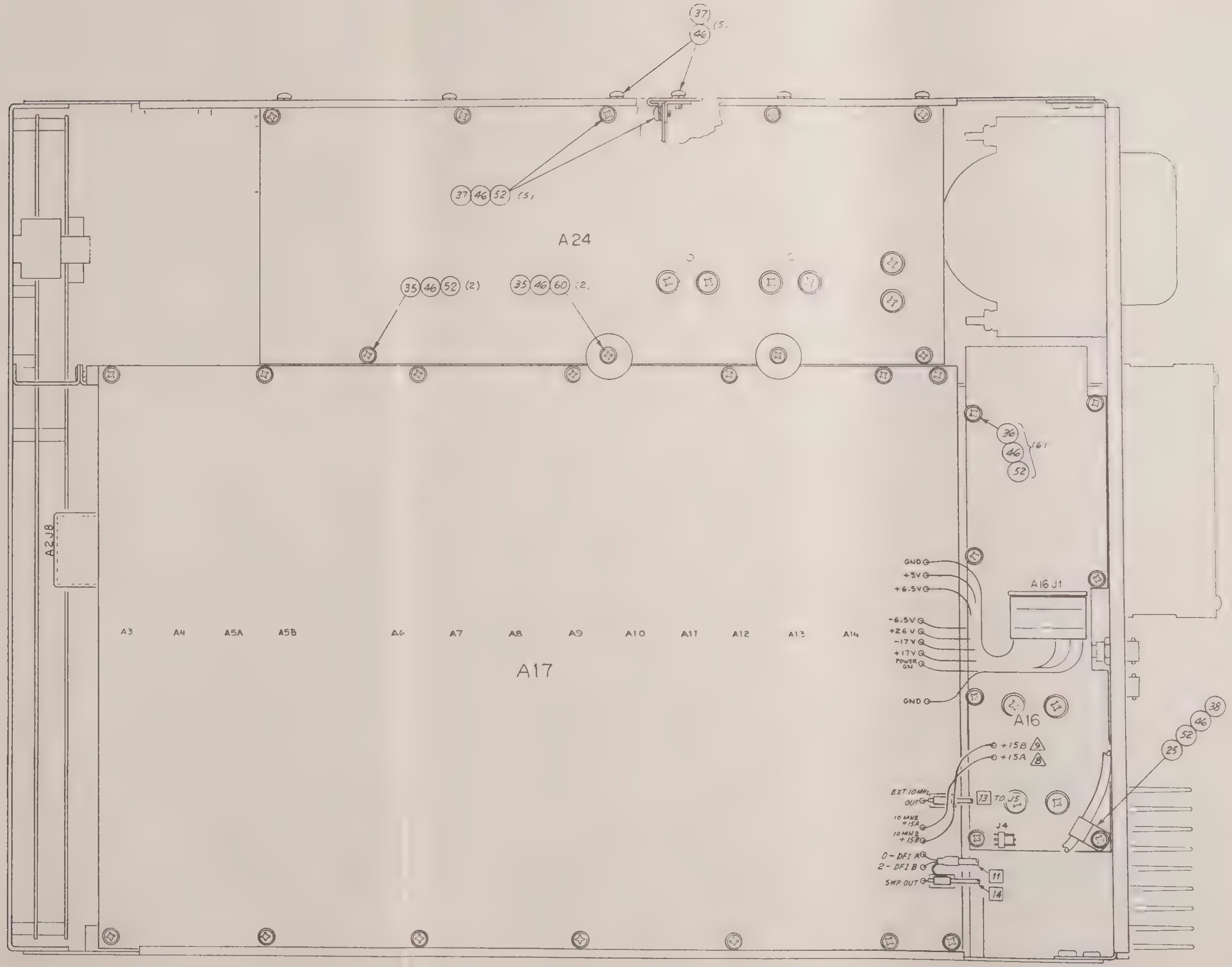
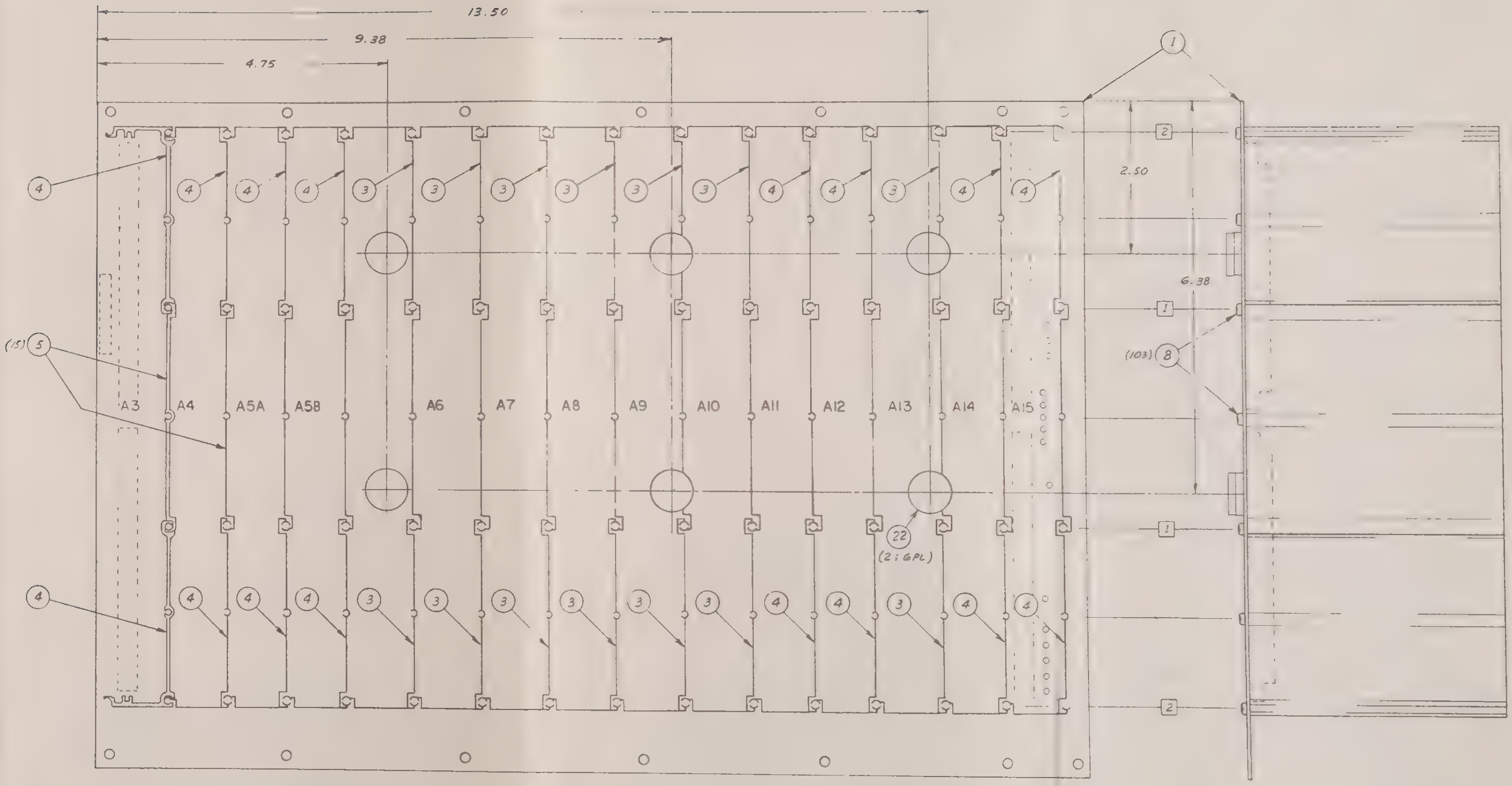

42 (3)
106
(2) 30
58 APPLIED TO ITEM 104 ENDS
43 (3)
S1
J2
100
80
A1
A2
A17
A3
A4
A5A
A5B
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
J8
J1
J8
104
102
98, T1-8
A16
J3
FROM B1 FAN
B1
39 (2)
90-6 (FROM T1)
95-3 (FROM T1)
A24
A24 J1
FL 1
T1
46 36 2
102 REF
42 (3)
8
9
43 (3)
104 REF
96
U13
98 2
97 3
5 0
96
94
U14
94
904 4
95 1
8 WIRES FROM T1
FROM A24
20 91
93
92
U11
U12
92
93
U10
U9
U3
U7
U2
U8
U6
58 APPLY TO A16, R3 THERMISTOR & INSERT INTO HOLE OF ITEM 104.
47 36
5
15
WIRES & CABLE ASSY'S
SYMBOL
⬡ W/L 507728401 CHASSIS - COAX .
⬭ W/L 507730901 FRONT PANEL .
☐ W/L 507778501 REAR PANEL .
△ W/L 507778601 PCB POWER SUPPLY .
○ PL 07728401 (REF).

Figure 5-4. Chassis Assembly (Sheet 1 of 2)



37
46
(5)
37 46 52 (5)
A24
35 46 52 (2)
35 46 60 (2)
36
46
52
(6)
A2J8
A3
A4
A5A
A5B
A6
A7
A8
A9
A10
A11
A12
A13
A14
A17
GND
+5V
+6.5V
-6.5V
+26V
-17V
+17V
POWER ON
GND
A16 J1
A16
+15B 9
+15A 8
EXT 10MHz OUT
13 TO J5
10MHz +15A
10MHz +15B
J4
0-DFI A
2-DFI B
SWP OUT
11
14
38
46
52
25

Figure 5-4. Chassis Assembly (Sheet 2 of 2)


13.50
9.38
4.75
2.50
6.38
(15) 5
(103) 8
22
(2; 6PL)
1
2
3
4
A3
A4
A5A
A5B
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15

NOTES:

1. ABOVE VIEW SHOWN FROM BOTTOM OR 'CIRCUIT' SIDE WITH ITEM 1, A17 MOTHER BOARD ASSENBLY TRANSPARENT.
2. ITEMS 3,4 & 5; EXTRUSION PARTS, TO BE MOUNTED ON COMPONENT SIDE. ITEMS 4 & 5 OF SECTION A4 SHOWN TO SCALE, ALL OTHERS IN SCHEMATIC FORM.
3. INSTALL ABOVE PARTS WITH SCREWS, ITEM 8 IN SEQUENCE BY ROW No's ☐. ROWS NOT NUMBERED; LAST. ALL SCREWS TO BE TIGHTENED TO 8.0 IN. LBS. ALL EXTRUSION PARTS MUST BE MOUNTED WITH FULL CONTACT TO CIRCUIT BOARD ITEM 1.
4 SEE SHT. 2 FOR OTHER PARTS TO COMPLETE ASSEMBLY.

Figure 5-5. Printed Circuit (PC) Enclosure (Sheet 1 of 2)

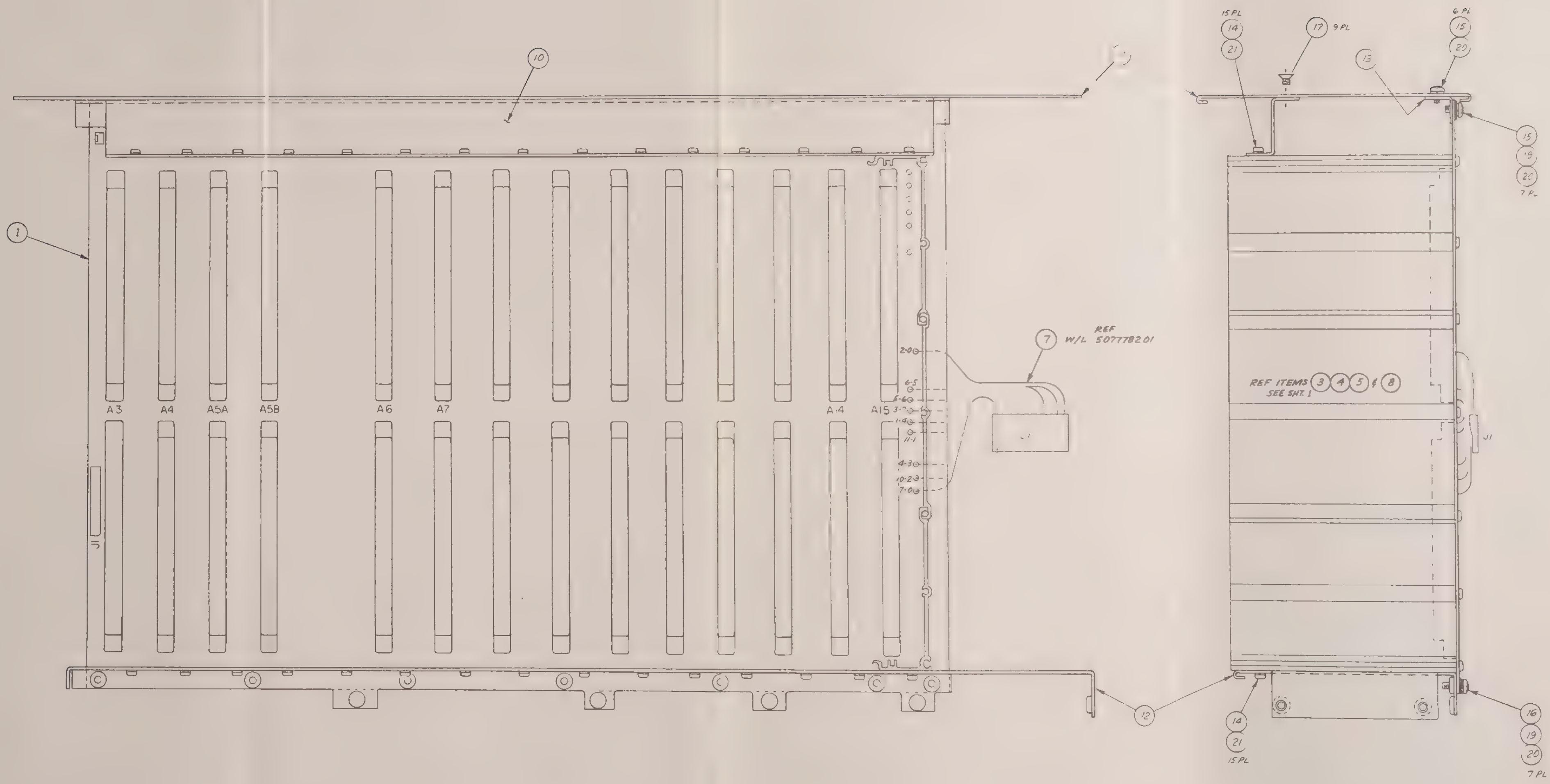
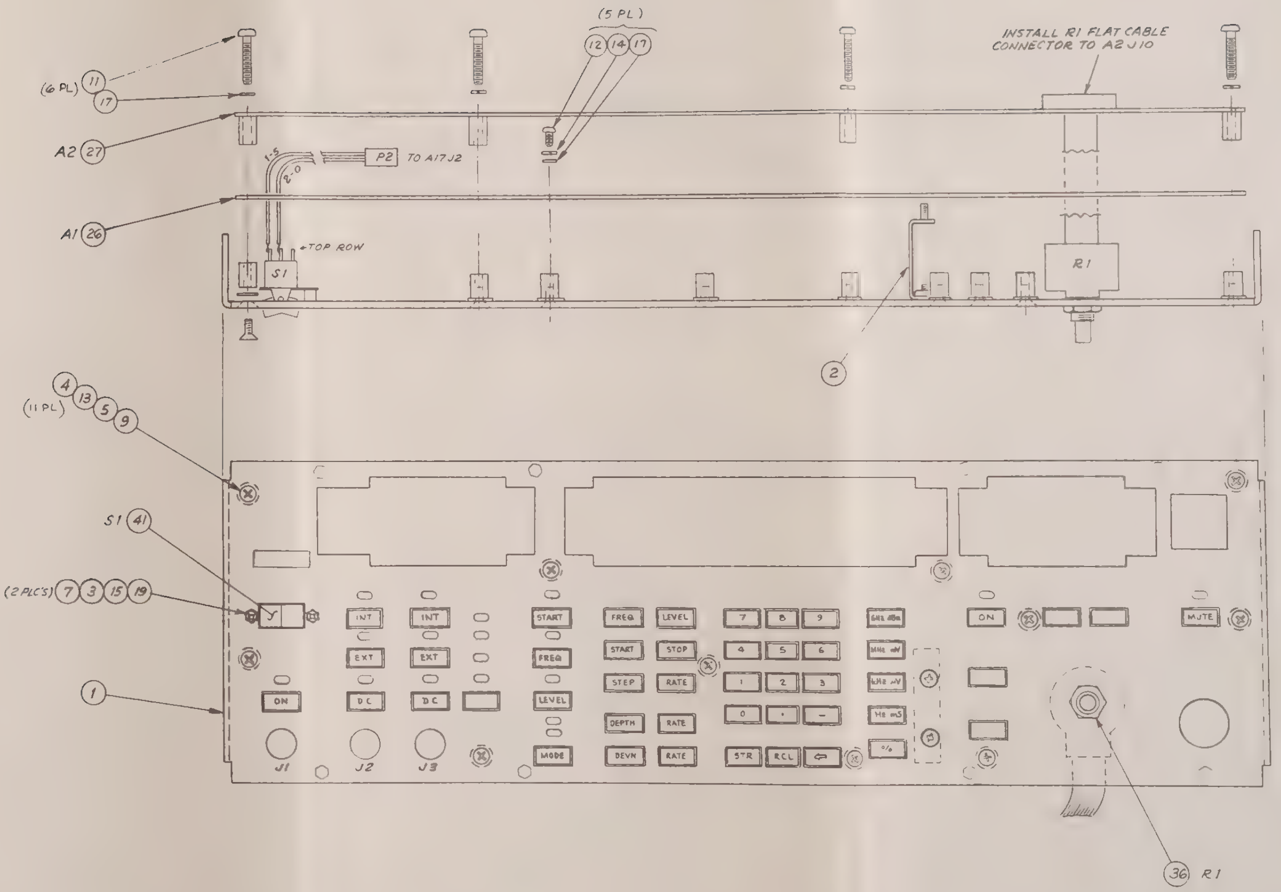
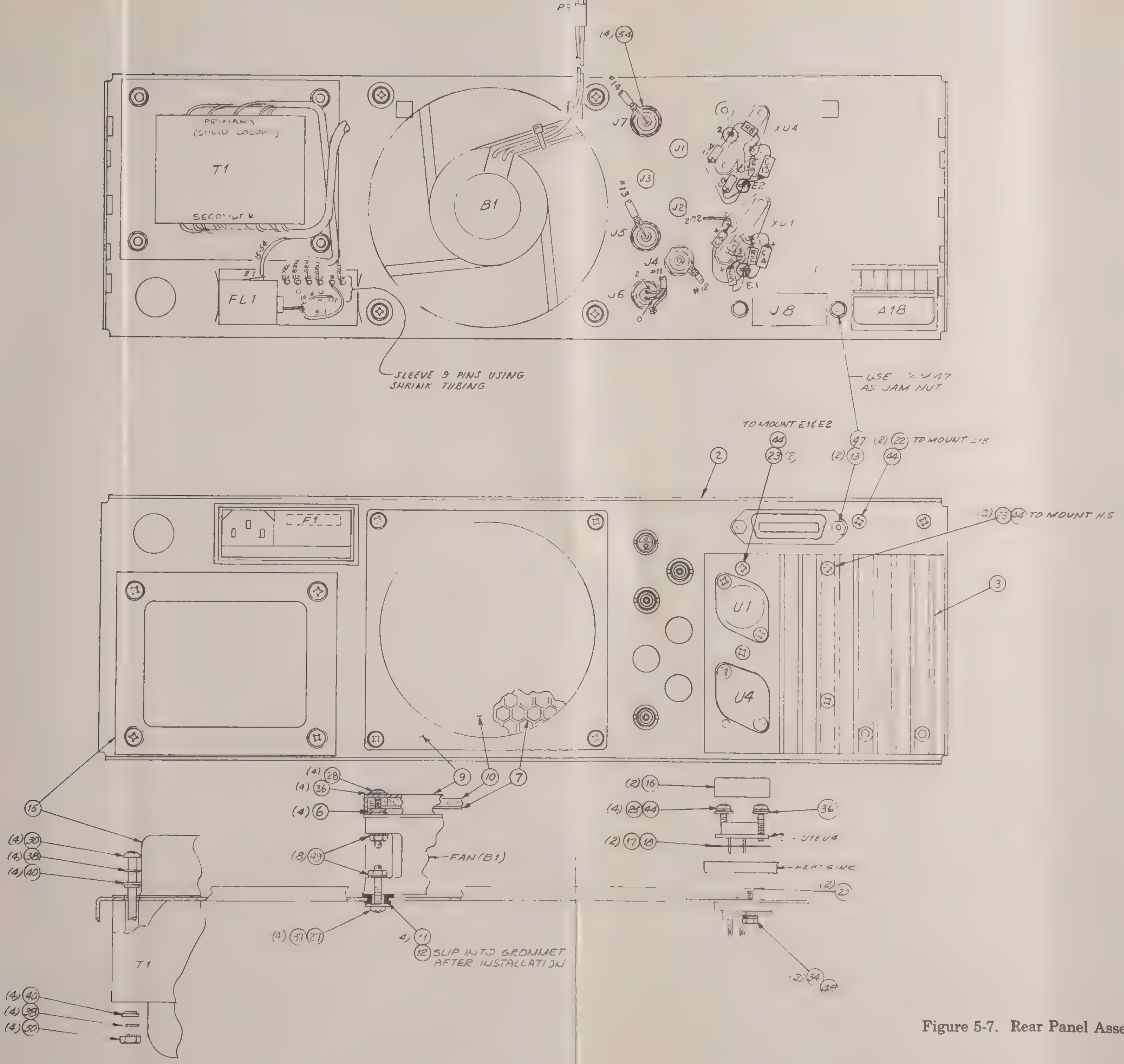

10
1
A3
A4
A5A
A5B
A6
A7
A14
A15
J1
2-0
6-5
5-6
3-7
1-4
11-1
4-3
10-2
7-0
7
REF
W/L 507778201
12
15 PL
14
21
17
9 PL
6 PL
15
20
13
15
19
20
7 PL
REF ITEMS 3 4 5 & 8
SEE SHT. 1
J1
14
21
15 PL
16
19
20
7 PL

Figure 5-5. Printed Circuit (PC) Enclosure (Sheet 2 of 2)


(5 PL)
12 14 17
INSTALL R1 FLAT CABLE CONNECTOR TO A2 J10
(6 PL) 11
17
A2 27
P2 TO A17 J2
A1 26
TOP ROW
S1
R1
2
(11 PL) 4 13 5 9
S1 41
(2 PLC'S) 7 3 15 19
1
INT
INT
START
FREQ
LEVEL
7
8
9
GHz dBm
ON
MUTE
EXT
EXT
FREQ
START
STOP
4
5
6
MHz mV
ON
DC
DC
LEVEL
STEP
RATE
1
2
3
kHz µV
DEPTH
RATE
0
.
–
Hz mS
MODE
DEVN
RATE
STR
RCL
⇦
%
J1
J2
J3
36 R1

NOTES:
1) REF DWG: WIRE LIST 5077339 01.
2) KEY CAPS FROM KEY CAPS KIT SHOWN INSTALLED. (P/L ITEM 29)

Figure 5-6. Front Panel Assembly


P3
(4) 54
#14
J7
J1
J3
J2
#13
J5
J4
J6
#11
#12
XU4
XU1
E1
E2
J8
A18
T1
PRIMARY
SECONDARY
B1
FL1
SLEEVE 9 PINS USING
SHRINK TUBING
USE 47
AS JAM NUT
TO MOUNT E1 & E2
44
23
47
(2) 22 TO MOUNT A18
(2) 13
44
2
(2) 23 44 TO MOUNT H.S
3
U1
U4
F1
15
(4) 28
(4) 36
(4) 6
9
10
7
(4) 30
(4) 38
(4) 40
(8) 49
FAN (B1)
(4) 37 27
(4) 11
12 SLIP INTO GROMMET
AFTER INSTALLATION
T1
(4) 40
(4) 38
(4) 50
(2) 16
(4) 25 44
36
(2) 17 18
U1 & U4
HEAT SINK
(2) 21
(2) 34
49

REF DWGS.:
WIRE LIST 507778501

Figure 5-7. Rear Panel Assembly

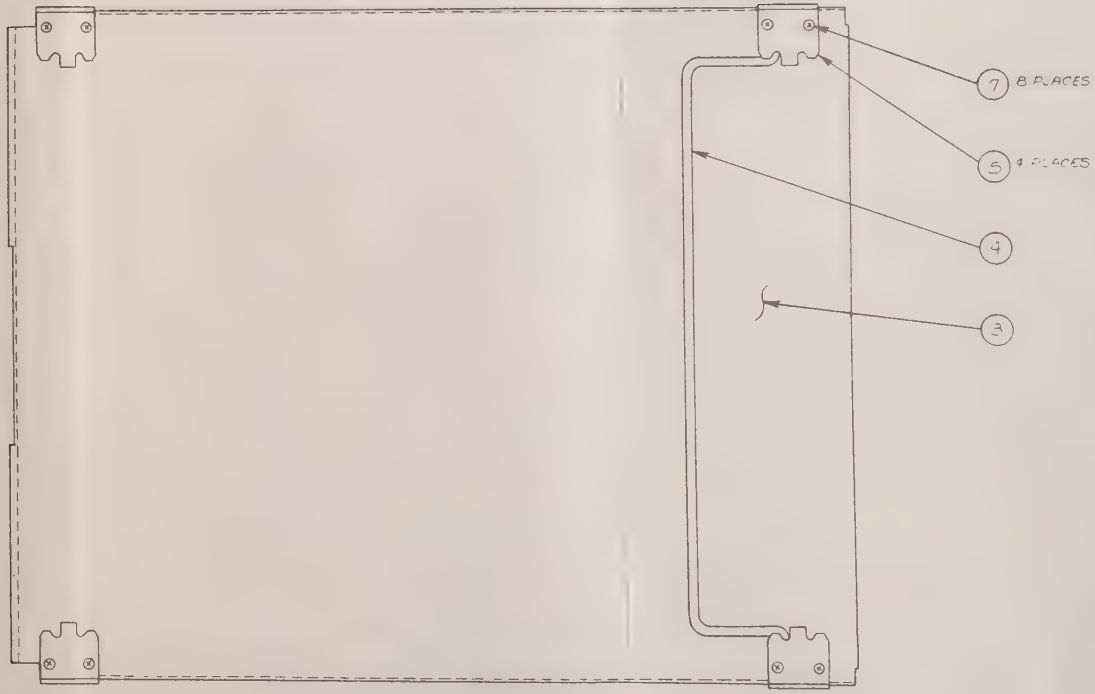

7 8 PLACES
5 4 PLACES
4
3

Figure 5-8. Bottom Cover Assembly

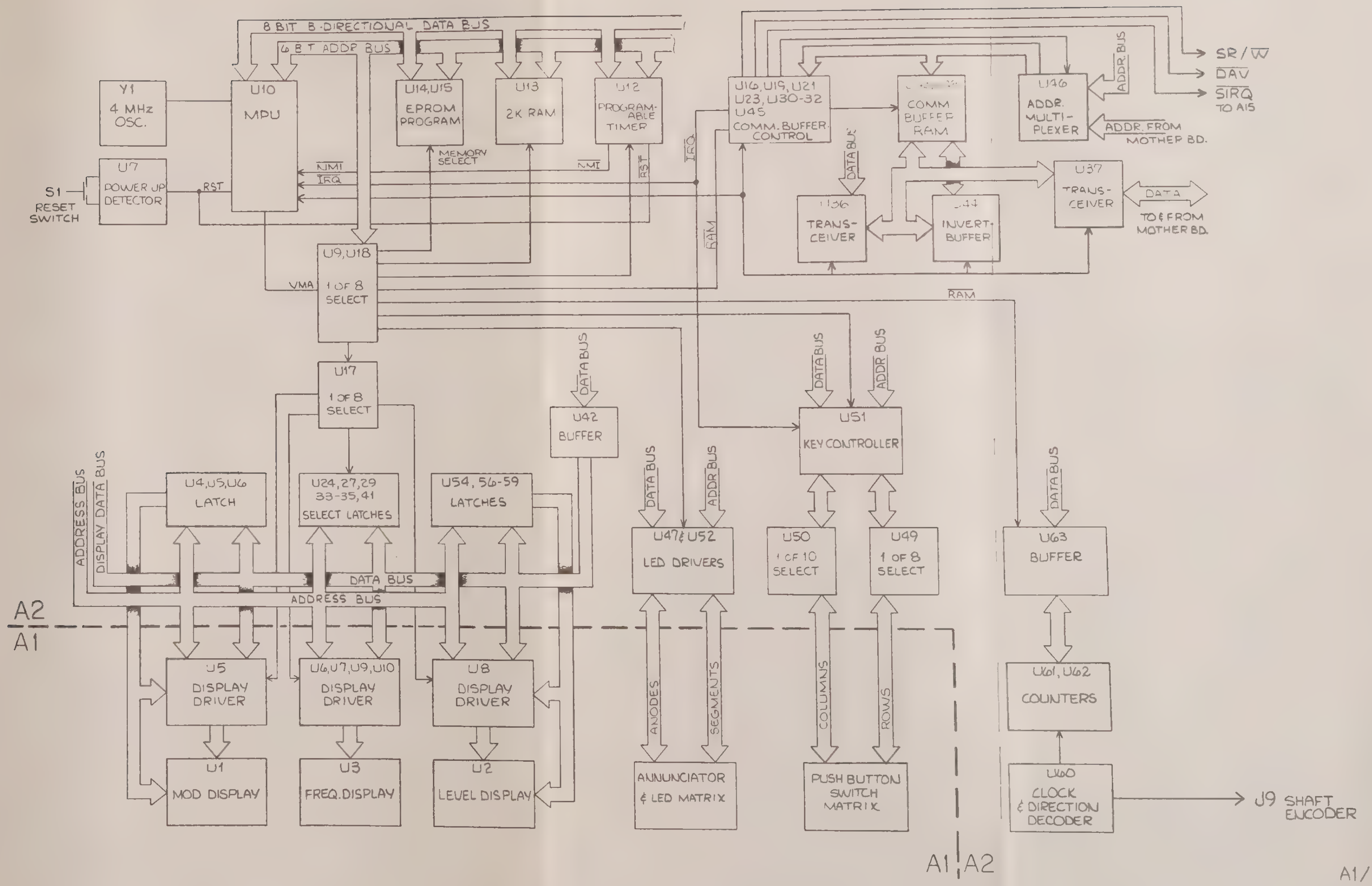
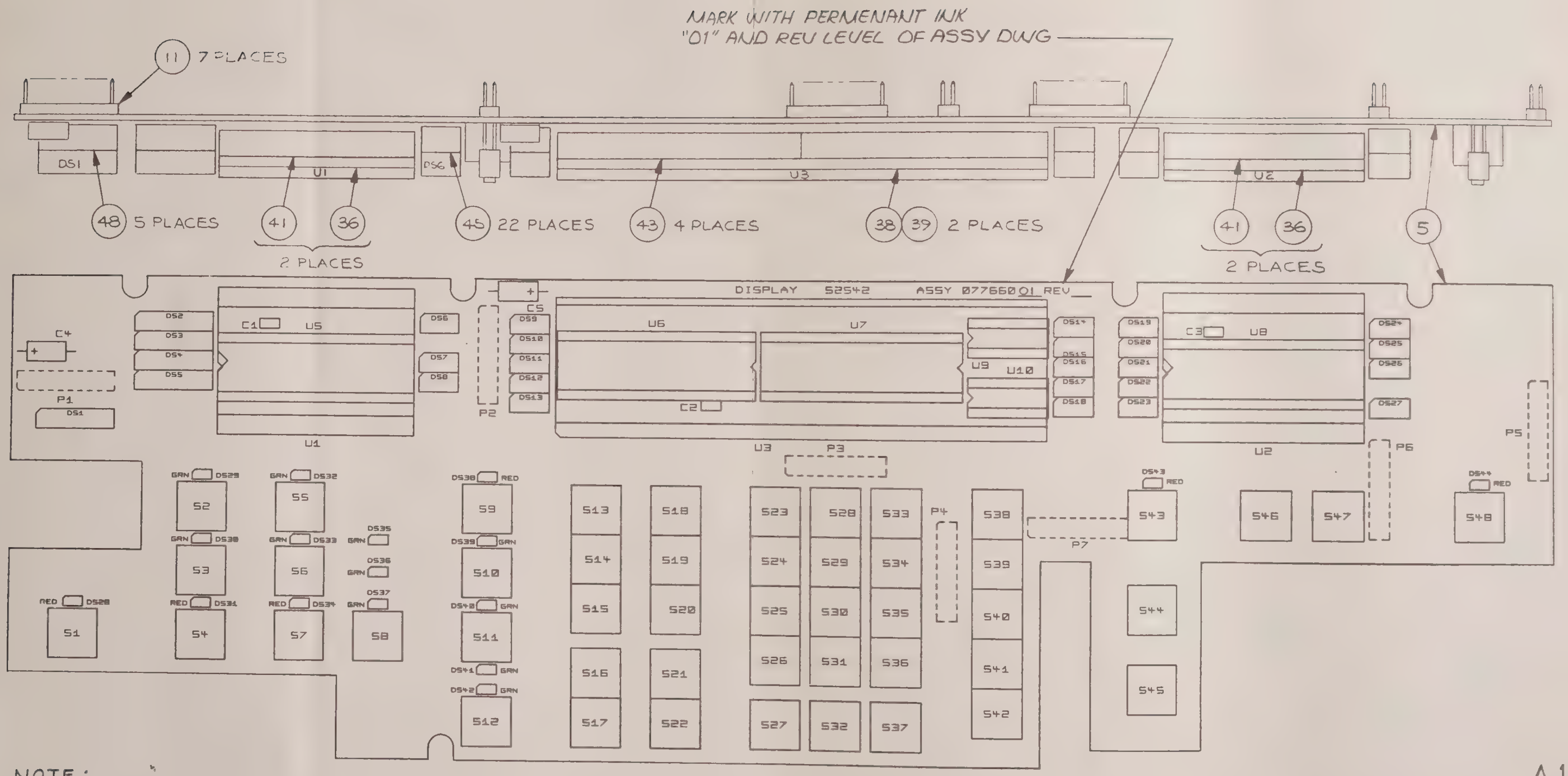
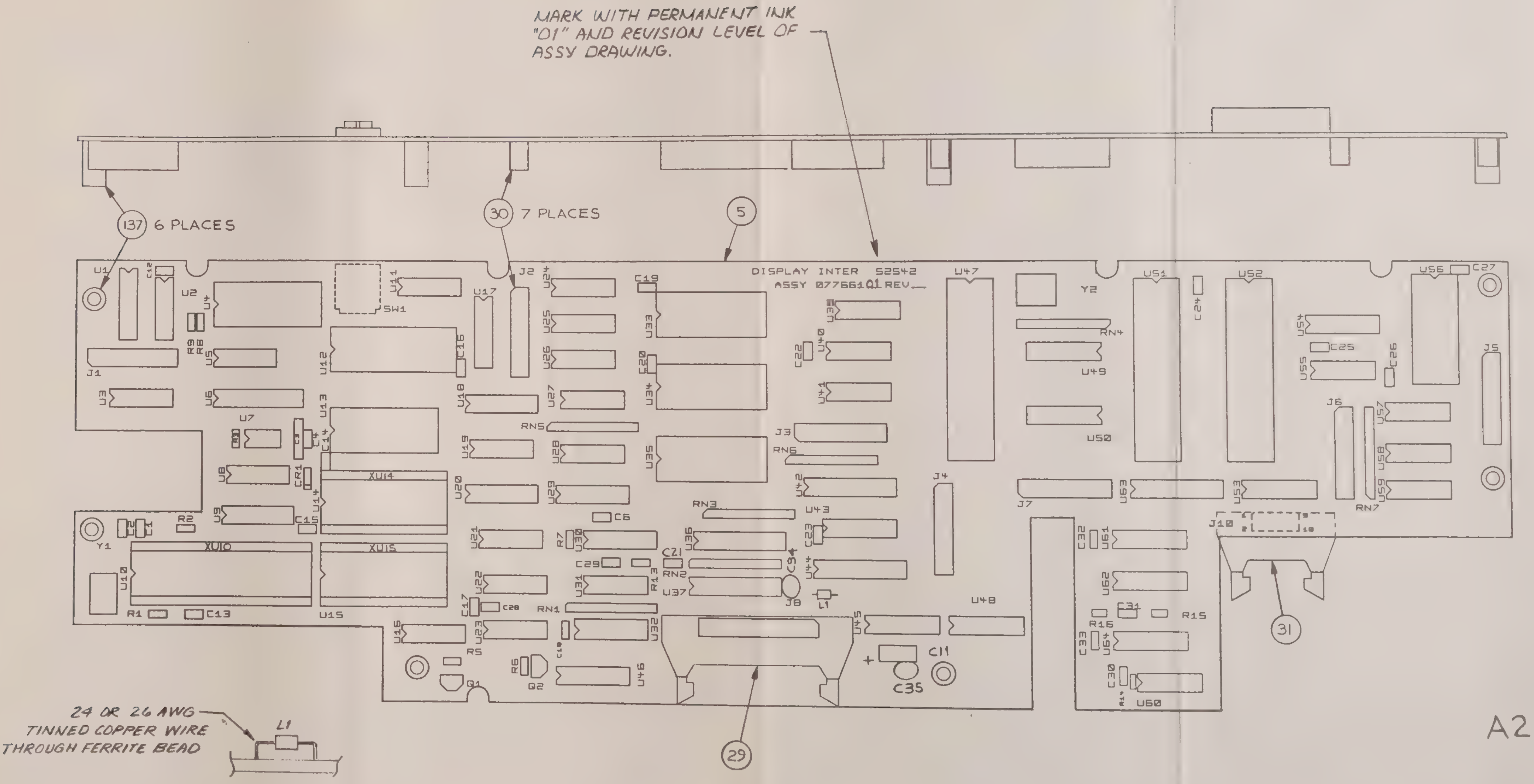

8 BIT BI-DIRECTIONAL DATA BUS
16 BIT ADDR BUS
Y1
4 MHz OSC.
U10
MPU
U14,U15
EPROM PROGRAM
U13
2K RAM
U12
PROGRAM-ABLE TIMER
U7
POWER UP DETECTOR
S1
RESET SWITCH
RST
NMI
IRQ
MEMORY SELECT
NMI
RST
IRQ
RAM
U9,U18
1 OF 8 SELECT
VMA
U16,U19,U21
U23,U30-32
U45
COMM. BUFFER CONTROL
COMM BUFFER RAM
U46
ADDR. MULTI-PLEXER
ADDR. BUS
ADDR. FROM MOTHER BD.
SR/W
DAV
SIRQ
TO A15
DATA BUS
U36
TRANS-CEIVER
U44
INVERT. BUFFER
U37
TRANS-CEIVER
DATA
TO & FROM MOTHER BD.
RAM
U17
1 OF 8 SELECT
DATA BUS
U42
BUFFER
DATA BUS
ADDR BUS
U51
KEY CONTROLLER
ADDRESS BUS
DISPLAY DATA BUS
U4,U5,U6
LATCH
U24,27,29
33-35,41
SELECT LATCHES
U54, 56-59
LATCHES
DATA BUS
ADDRESS BUS
DATA BUS
ADDR BUS
U47 & U52
LED DRIVERS
U50
1 OF 10 SELECT
U49
1 OF 8 SELECT
DATA BUS
U63
BUFFER
A2
A1
U5
DISPLAY DRIVER
U6,U7,U9,U10
DISPLAY DRIVER
U8
DISPLAY DRIVER
ANODES
SEGMENTS
COLUMNS
ROWS
U61, U62
COUNTERS
U1
MOD DISPLAY
U3
FREQ. DISPLAY
U2
LEVEL DISPLAY
ANNUNCIATOR & LED MATRIX
PUSH BUTTON SWITCH MATRIX
U60
CLOCK & DIRECTION DECODER
J9 SHAFT ENCODER
A1 A2
A1/A2

Figure 5-9. Keyboard and Display A1 and Front Panel Interface A2 Block Diagram


MARK WITH PERMENANT INK
"01" AND REV LEVEL OF ASSY DWG
11 7 PLACES
48 5 PLACES
41 36 2 PLACES
45 22 PLACES
43 4 PLACES
38 39 2 PLACES
41 36 2 PLACES
5
DS1
U1
DS6
U3
U2
DISPLAY 52542 ASSY 077660 01 REV
C4
P1
DS1
DS2
DS3
DS4
DS5
C1
U5
U1
DS6
DS7
DS8
P2
C5
DS9
DS10
DS11
DS12
DS13
U6
U7
C2
U3
U9
U10
DS14
DS15
DS16
DS17
DS18
DS19
DS20
DS21
DS22
DS23
C3
U8
U2
DS24
DS25
DS26
DS27
P3
P4
P5
P6
P7
GRN DS29
GRN DS32
GRN DS30
GRN DS33
RED DS28
RED DS31
RED DS34
DS35 GRN
DS36 GRN
DS37 GRN
DS38 RED
DS39 GRN
DS40 GRN
DS41 GRN
DS42 GRN
DS43 RED
DS44 RED
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
S17
S18
S19
S20
S21
S22
S23
S24
S25
S26
S27
S28
S29
S30
S31
S32
S33
S34
S35
S36
S37
S38
S39
S40
S41
S42
S43
S44
S45
S46
S47
S48
A1

NOTE:
1) USE ASSEMBLY FIXTURE SD *083106 LATEST REV.
TO SET HEIGHT OF SOCKETS U1 → 3 AND DS1 → 44.
SWITCHES S1 → 48 WILL ALSO BE INSTALLED USING
THIS FIXTURE.
2) TRIM LEADS ON SOCKETS OF DS15 & DS20 TO 1/16" LONG.

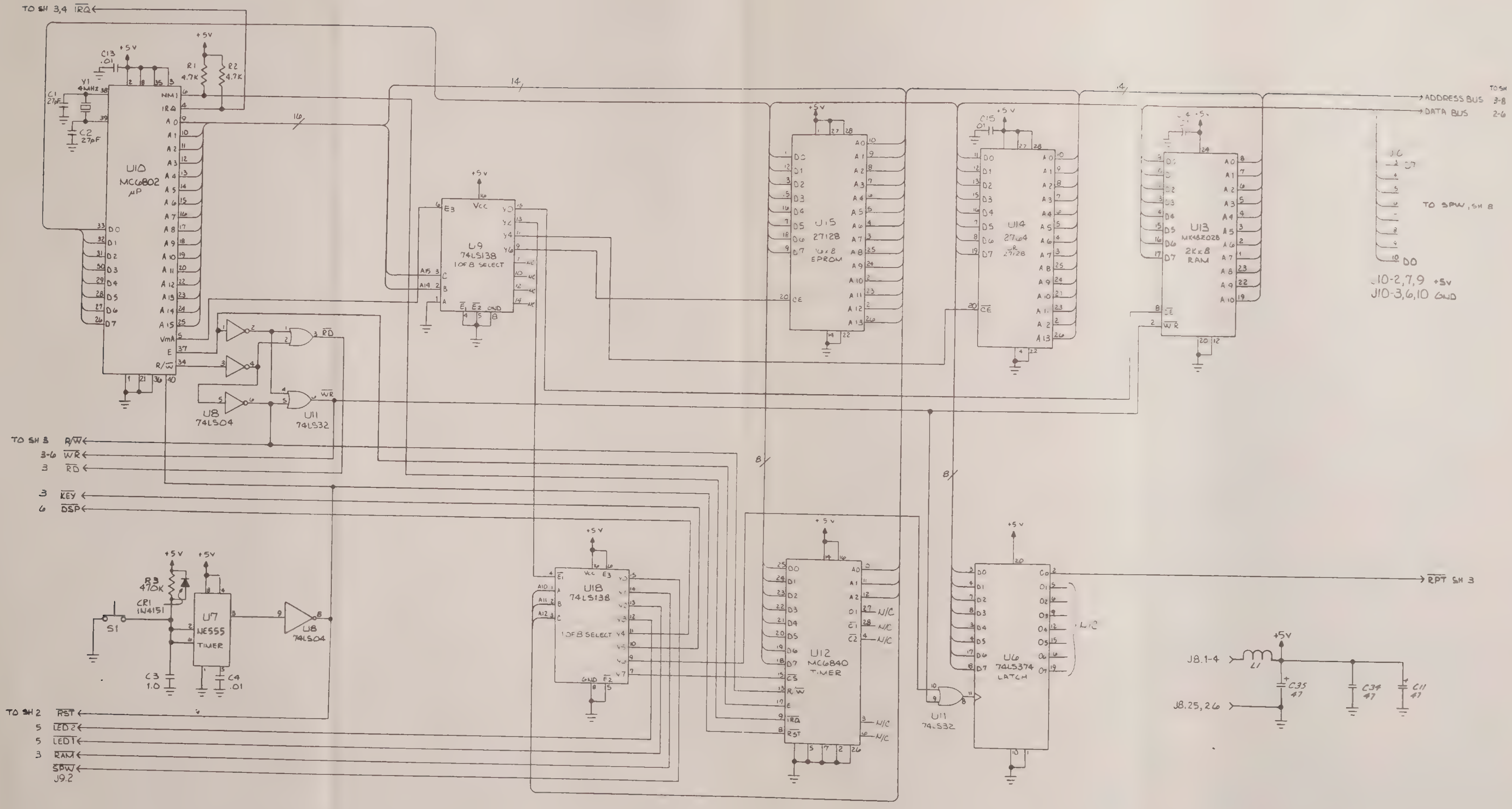
Figure 5-10. Keyboard and Display PC Board Assembly A1


MARK WITH PERMANENT INK "01" AND REVISION LEVEL OF ASSY DRAWING.

24 OR 26 AWG TINNED COPPER WIRE THROUGH FERRITE BEAD

137 6 PLACES
30 7 PLACES
5
29
31
DISPLAY INTER 52542
ASSY 077661 01 REV__
A2
L1
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
U14
U15
U16
U17
U18
U19
U20
U21
U22
U23
U24
U25
U26
U27
U28
U29
U30
U31
U32
U33
U34
U35
U36
U37
U38
U39
U40
U41
U42
U43
U44
U45
U46
U47
U48
U49
U50
U51
U52
U53
U54
U55
U56
U57
U58
U59
U60
U61
U62
U63
U64
XU10
XU14
XU15
J1
J2
J3
J4
J5
J6
J7
J8
J10
SW1
Y1
Y2
Q1
Q2
CR1
RN1
RN2
RN3
RN4
RN5
RN6
RN7
R1
R2
R5
R6
R7
R8
R9
R13
R14
R15
R16
C1
C3
C4
C6
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
C32
C33
C34
C35

Figure 5-11. Front Panel Interface PC Board Assembly A2


TO SH 3,4 IRQ
U10
MC6802
μP
Y1
4MHZ
C1
27pF
C2
27pF
C13
.01
R1
4.7K
R2
4.7K
+5V
NMI
IRQ
VmA
E
R/W
U9
74LS138
1 OF 8 SELECT
A15
A14
U8
74LS04
U11
74LS32
RD
WR
U15
27128
16K×8
EPROM
U14
2764
OR
27128
C15
.01
U13
MK48Z02B
2K×8
RAM
ADDRESS BUS
DATA BUS
TO SH 3-8
2-6
J10
D7
D0
TO SPW, SH 8
J10-2,7,9 +5V
J10-3,6,10 GND
TO SH 3 R/W
3-6 WR
3 RD
3 KEY
6 DSP
R3
470K
CR1
1N4151
S1
U7
NE555
TIMER
C3
1.0
C4
.01
U18
74LS138
1 OF 8 SELECT
A10
A11
A12
U12
MC6840
TIMER
N/C
U6
74LS374
LATCH
RPT SH 3
TO SH 2 RST
5 LED2
5 LED1
3 RAM
SPW
J9.2
J8.1-4
J8.25,26
L1
C35
47
C34
47
C11
47

NOTES UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS 1/4W 5%
2. CAPACITORS ARE IN MICROFARADS.
3. L1 IS A FERRITE BEAD

Figure 5-12. Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 1 of 8)

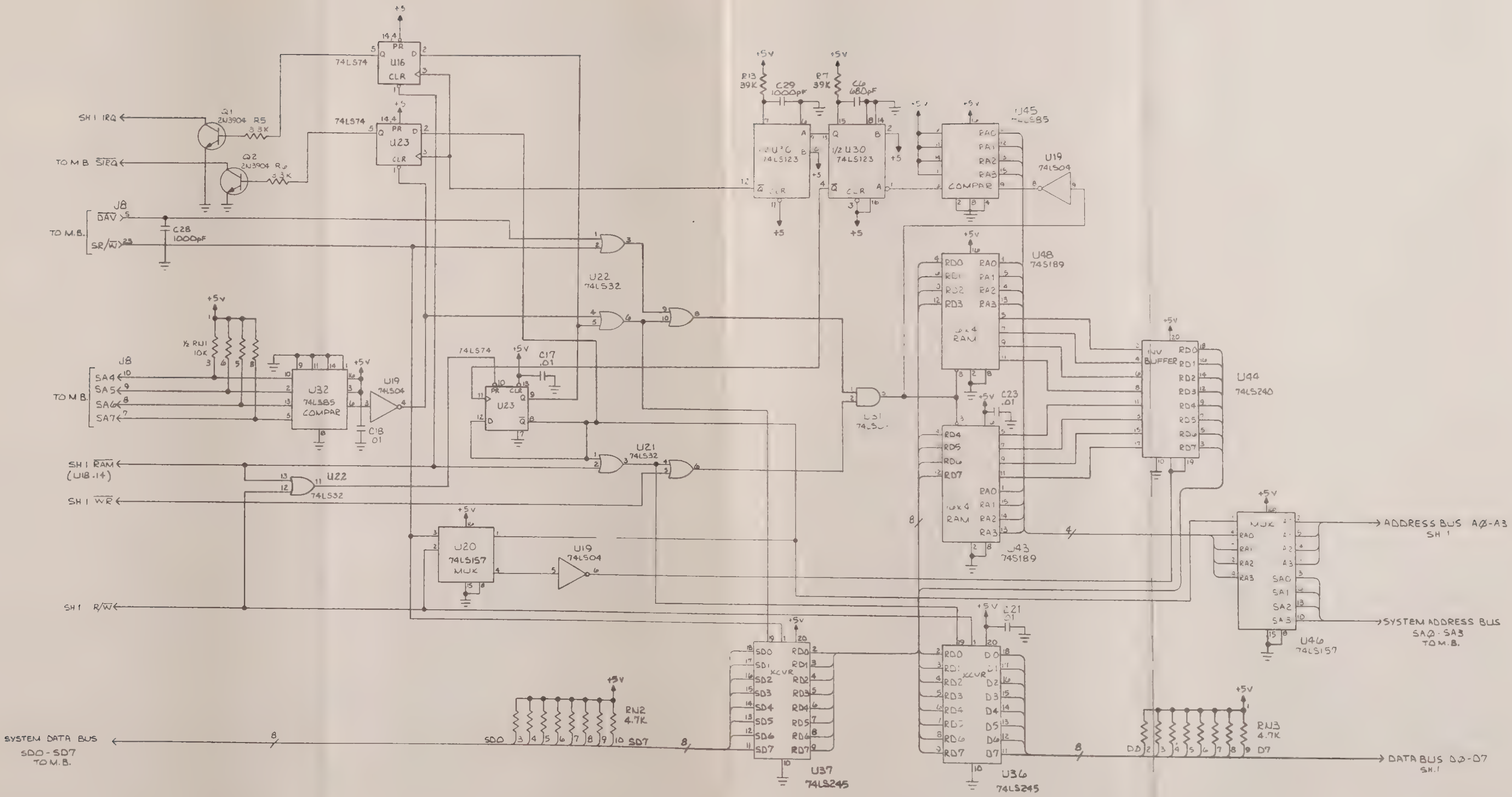

SH 1 IRQ
TO M.B. SIRQ
Q1 2N3904
Q2 2N3904
R5 3.3K
R6 3.3K
U16 74LS74
U23 74LS74
J8
DAV
SR/W
TO M.B.
C28 1000pF
U22 74LS32
½ RN1 10K
SA4
SA5
SA6
SA7
U32 74LS85 COMPAR
U19 74LS04
C18 .01
C17 .01
U21 74LS32
SH 1 RAM (U18.14)
SH 1 WR
SH 1 R/W
U20 74LS157 MUX
R13 39K
C29 1000pF
R7 39K
C6 680pF
½ U30 74LS123
U45 74LS85 COMPAR
U31 74LS00
U48 74S189 16x4 RAM
U43 74S189 16x4 RAM
C23 .01
U44 74LS240 INV BUFFER
U46 74LS157 MUX
ADDRESS BUS A0-A3 SH 1
SYSTEM ADDRESS BUS SA0-SA3 TO M.B.
C21 .01
U37 74LS245 XCVR
U36 74LS245 XCVR
RN2 4.7K
RN3 4.7K
SYSTEM DATA BUS SD0-SD7 TO M.B.
DATA BUS D0-D7 SH.1
+5V

Figure 5-12. Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 2 of 8)

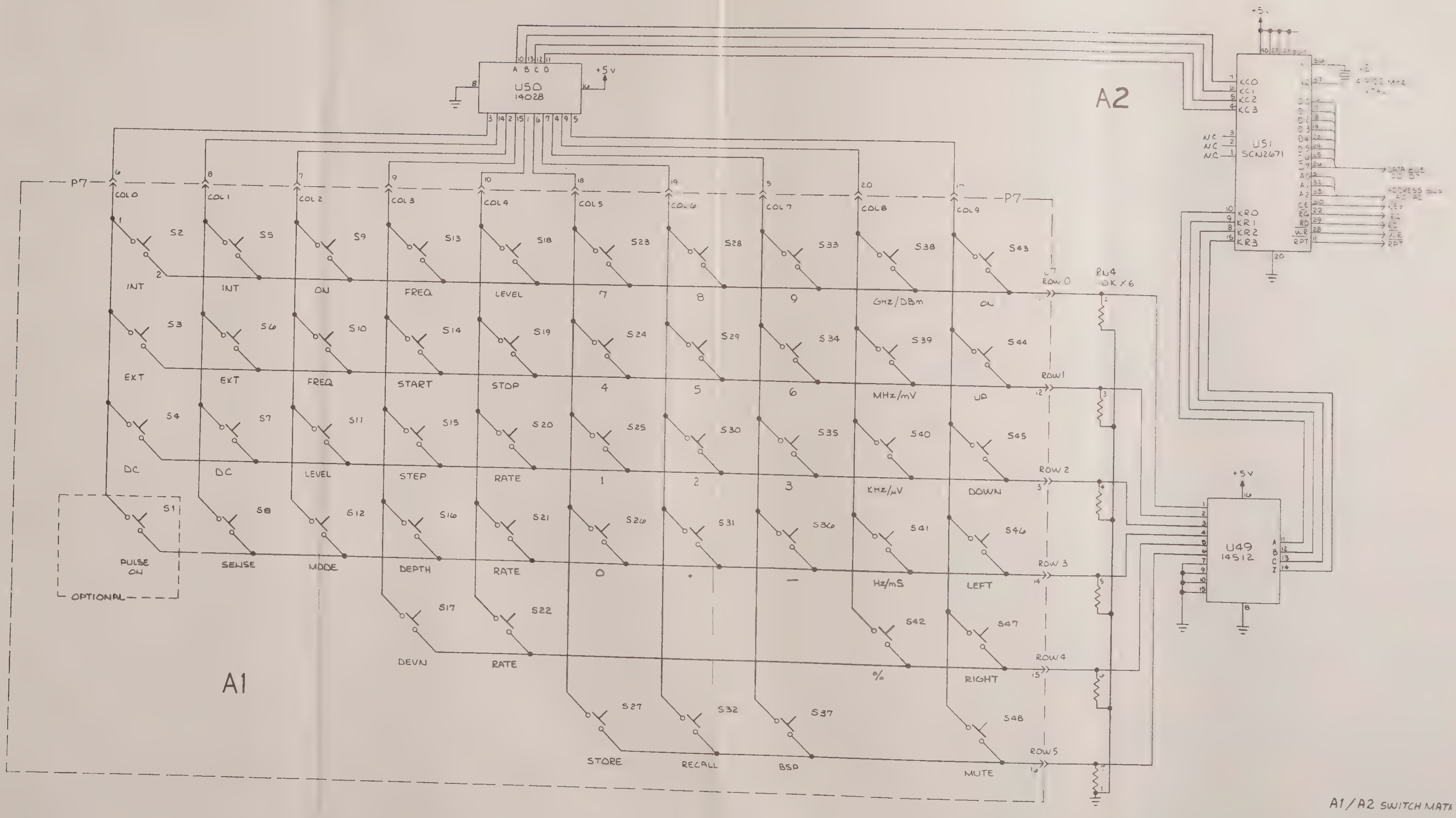

U50
14028
A B C D
+5V
U51
SCN2671
KC0
KC1
KC2
KC3
KR0
KR1
KR2
KR3
N.C.
DATA BUS
ADDRESS BUS
RPT
+5V
U49
14512
A2
A1
P7
RN4
ROW 0
ROW 1
ROW 2
ROW 3
ROW 4
ROW 5
COL 0
COL 1
COL 2
COL 3
COL 4
COL 5
COL 6
COL 7
COL 8
COL 9
S1
PULSE ON
OPTIONAL
S2
INT
S3
EXT
S4
DC
S5
INT
S6
EXT
S7
DC
S8
SENSE
S9
ON
S10
FREQ
S11
LEVEL
S12
MODE
S13
FREQ
S14
START
S15
STEP
S16
DEPTH
S17
DEVN
S18
LEVEL
S19
STOP
S20
RATE
S21
RATE
S22
RATE
S23
7
S24
4
S25
1
S26
0
S27
STORE
S28
8
S29
5
S30
2
S31
.
S32
RECALL
S33
9
S34
6
S35
3
S36
—
S37
BSP
S38
GHz/DBm
S39
MHz/mV
S40
KHz/μV
S41
Hz/mS
S42
%
S43
ON
S44
UP
S45
DOWN
S46
LEFT
S47
RIGHT
S48
MUTE
A1/A2 SWITCH MATR

Figure 5-12. Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 3 of 8)

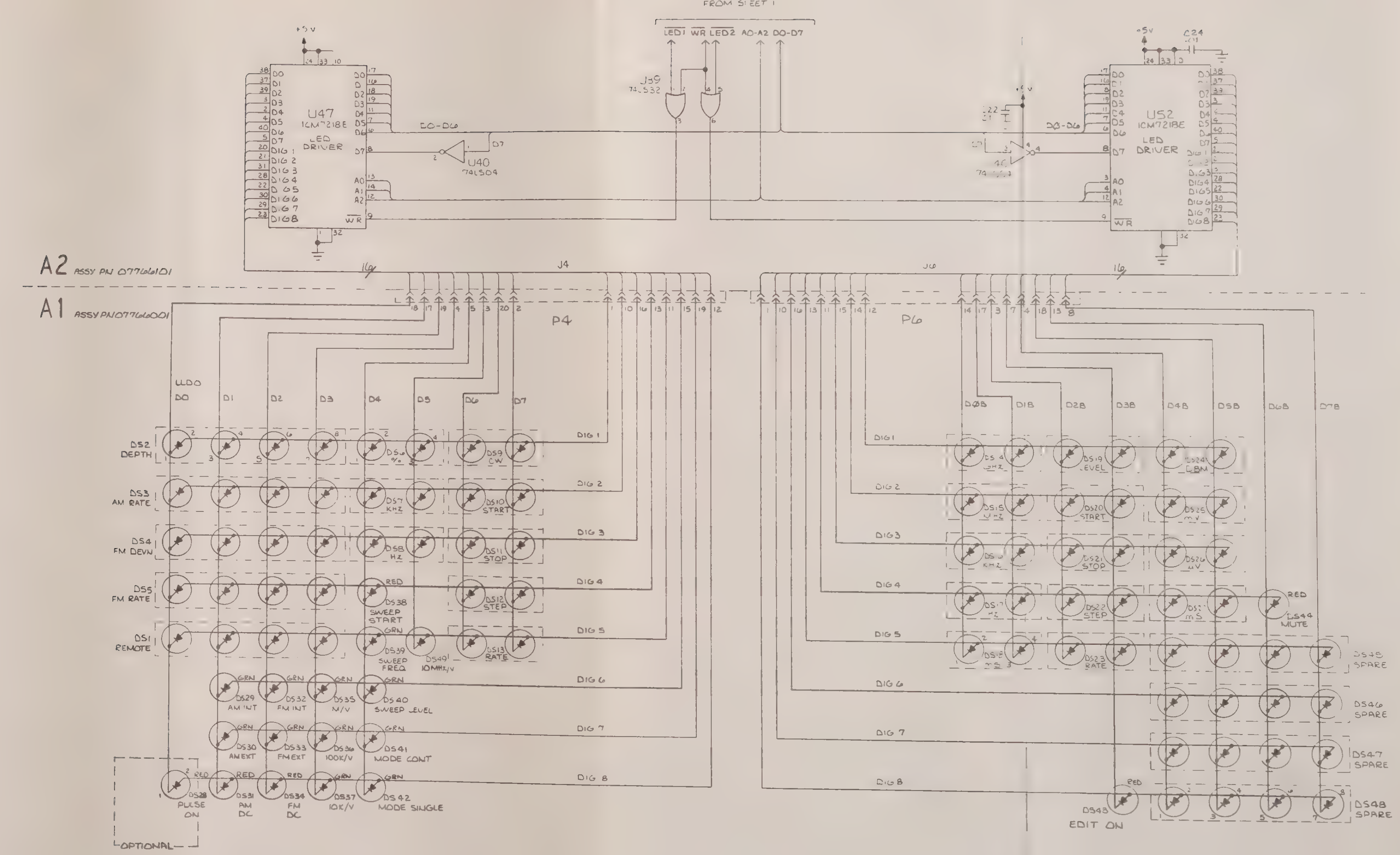

FROM SHEET 1
LED1
WR
LED2
A0-A2
D0-D7
+5V
U47
ICM7218E
LED DRIVER
D0-D6
D7
U40
74LS04
U39
74LS32
U52
ICM7218E
LED DRIVER
C22
C24
A2 ASSY PN 07766101
A1 ASSY PN 07766001
J4
J6
P4
P6
DIG 1
DIG 2
DIG 3
DIG 4
DIG 5
DIG 6
DIG 7
DIG 8
DS2 DEPTH
DS3 AM RATE
DS4 FM DEVN
DS5 FM RATE
DS1 REMOTE
DS6 %
DS7 KHZ
DS8 HZ
DS9 CW
DS10 START
DS11 STOP
DS12 STEP
DS13 RATE
DS38 SWEEP START
DS39 SWEEP FREQ
DS49 10MHz/V
DS29 AM INT
DS32 FM INT
DS35 M/V
DS40 SWEEP LEVEL
DS30 AM EXT
DS33 FM EXT
DS36 100K/V
DS41 MODE CONT
DS28 PULSE ON
DS31 AM DC
DS34 FM DC
DS37 10K/V
DS42 MODE SINGLE
OPTIONAL
RED
GRN
D0B
D1B
D2B
D3B
D4B
D5B
D6B
D7B
DS14 GHZ
DS15 MHZ
DS16 KHZ
DS17 HZ
DS18 mS
DS19 LEVEL
DS20 START
DS21 STOP
DS22 STEP
DS23 RATE
DS24 DBM
DS25 mV
DS26 µV
DS27 mS
DS44 MUTE
DS45 SPARE
DS46 SPARE
DS47 SPARE
DS48 SPARE
DS43 EDIT ON

Figure 5-12. Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 4 of 8)

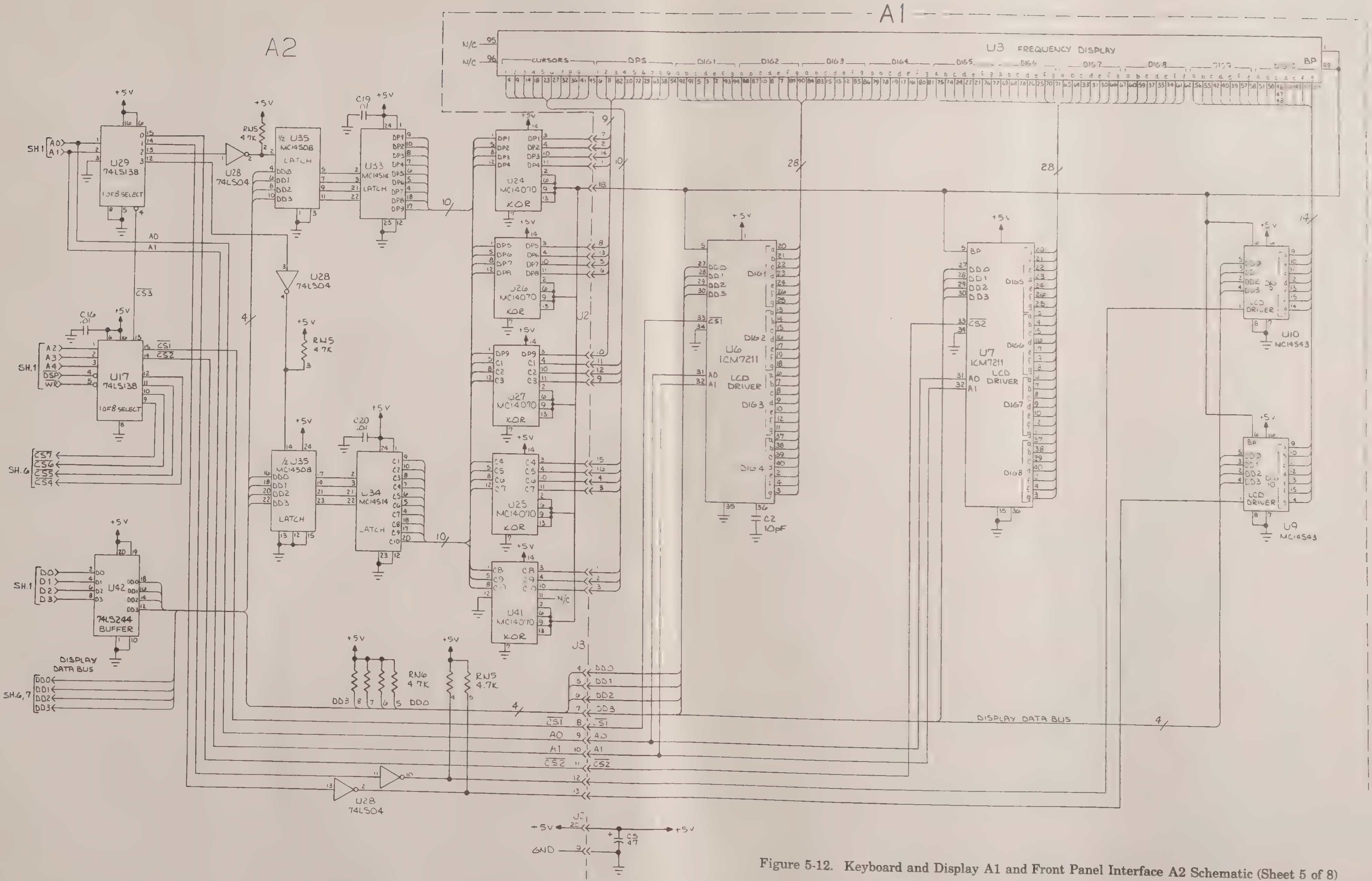

A1
A2
U3 FREQUENCY DISPLAY
CURSORS
DPS
DIG1
DIG2
DIG3
DIG4
DIG5
DIG6
DIG7
DIG8
BP
N/C
U29 74LS138 1 OF 8 SELECT
U17 74LS138 1 OF 8 SELECT
U42 74LS244 BUFFER
1/2 U35 MC14508 LATCH
U33 MC14514 LATCH
U34 MC14514 LATCH
U28 74LS04
U24 MC14070 XOR
U26 MC14070 XOR
U27 MC14070 XOR
U25 MC14070 XOR
U41 MC14070 XOR
U6 ICM7211 LCD DRIVER
U7 ICM7211 LCD DRIVER
U10 MC14543 LCD DRIVER
U9 MC14543 LCD DRIVER
RN5 4.7K
RN6 4.7K
C19 .01
C16 .01
C20 .01
C2 10pF
C5 47
SH.1
SH.6
SH.6,7
DISPLAY DATA BUS
J2
J3
+5V
GND

Figure 5-12. Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 5 of 8)

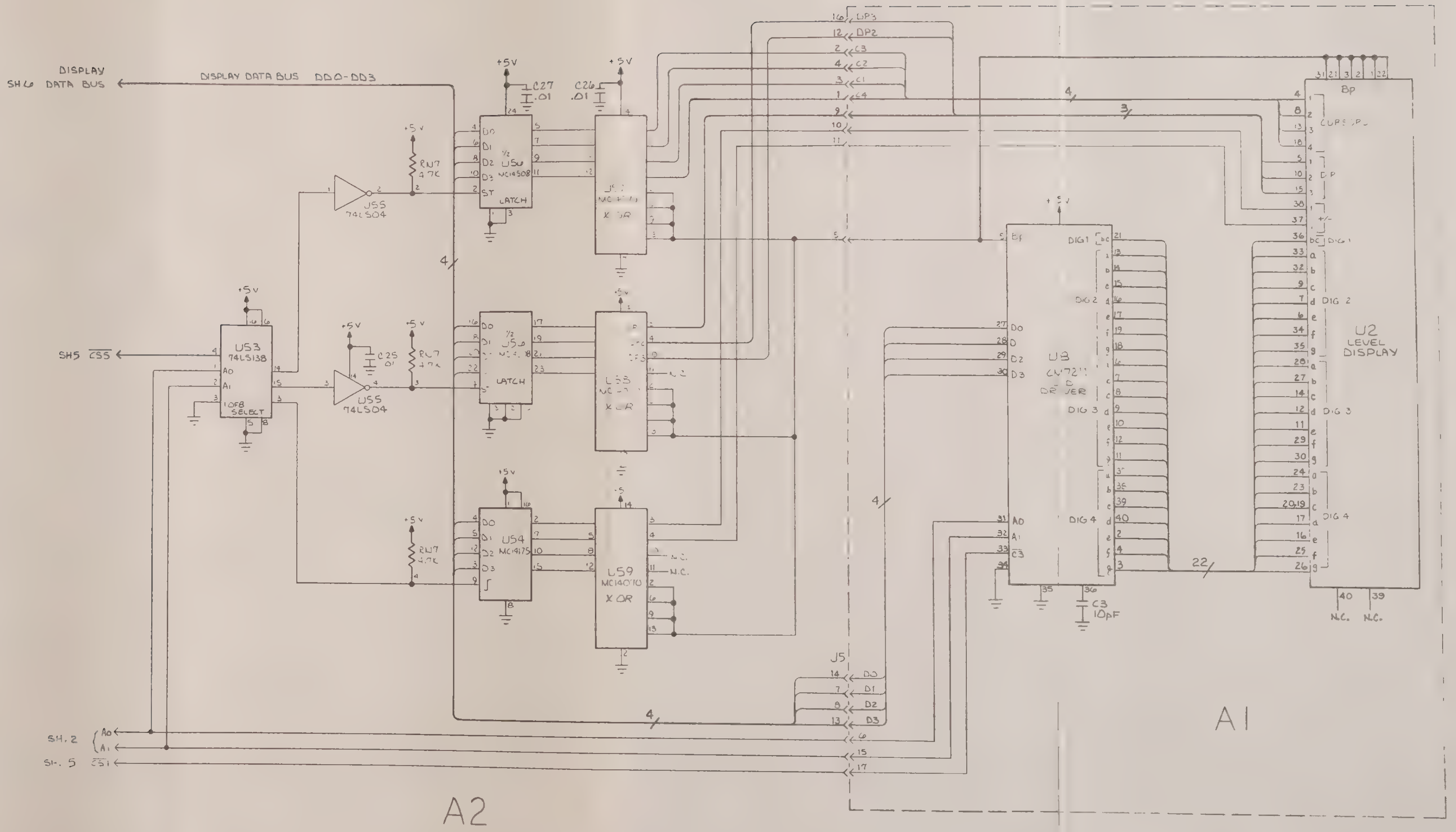
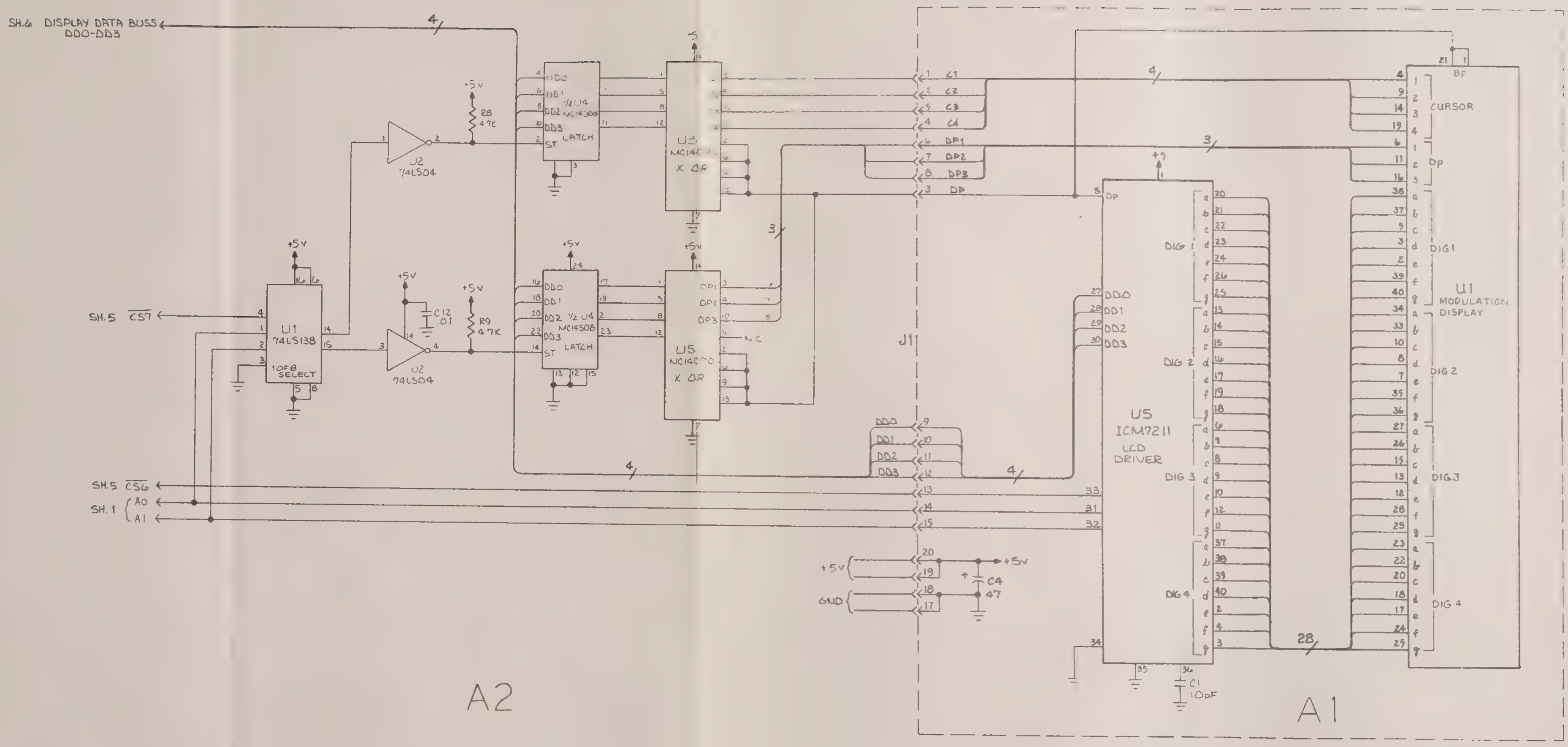

DISPLAY
SH6 DATA BUS
DISPLAY DATA BUS DD0-DD3
+5V
C27 .01
C26 .01
RN7 4.7K
U55 74LS04
U56 MC14508
LATCH
XOR
U53 74LS138
1 OF 8 SELECT
SH5 CS5
C25 .01
U54 MC14175
U59 MC14070
N.C.
J5
D0
D1
D2
D3
SH. 2 A0 A1
SH. 5 CS1
A2
DP3
DP2
C3
C2
C1
C4
U3
ICM7211
DRIVER
DIG 1
DIG 2
DIG 3
DIG 4
C3 10pF
U2
LEVEL DISPLAY
BP
DP
+/-
N.C.
A1

Figure 5-12. Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 6 of 8)


SH.6 DISPLAY DATA BUSS
DD0-DD3
SH.5 CS7
SH.5 CS6
SH.1 A0
A1
U1
74LS138
1OF8
SELECT
U2
74LS04
+5V
R8
4.7K
R9
4.7K
C12
.01
1/2 U4
MC14508
LATCH
DD0
DD1
DD2
DD3
ST
U3
MC14070
X OR
DP1
DP2
DP3
NC
J1
C1
C2
C3
C4
DP
+5V
GND
C4
47
U5
ICM7211
LCD
DRIVER
DIG 1
DIG 2
DIG 3
DIG 4
C1
10pF
U1
MODULATION
DISPLAY
CURSOR
BF
28
A2
A1

A1/A2 MODULATION DISPLAY

Figure 5-12. Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 7 of 8)

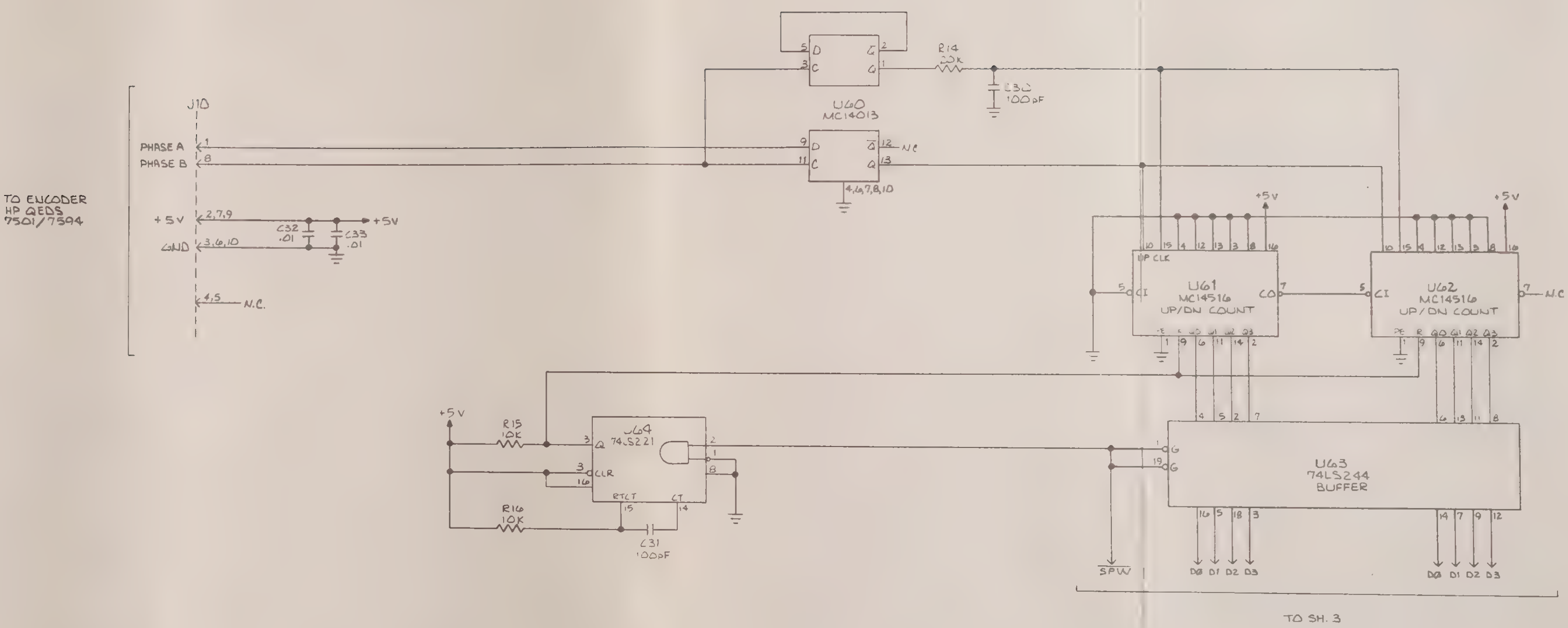
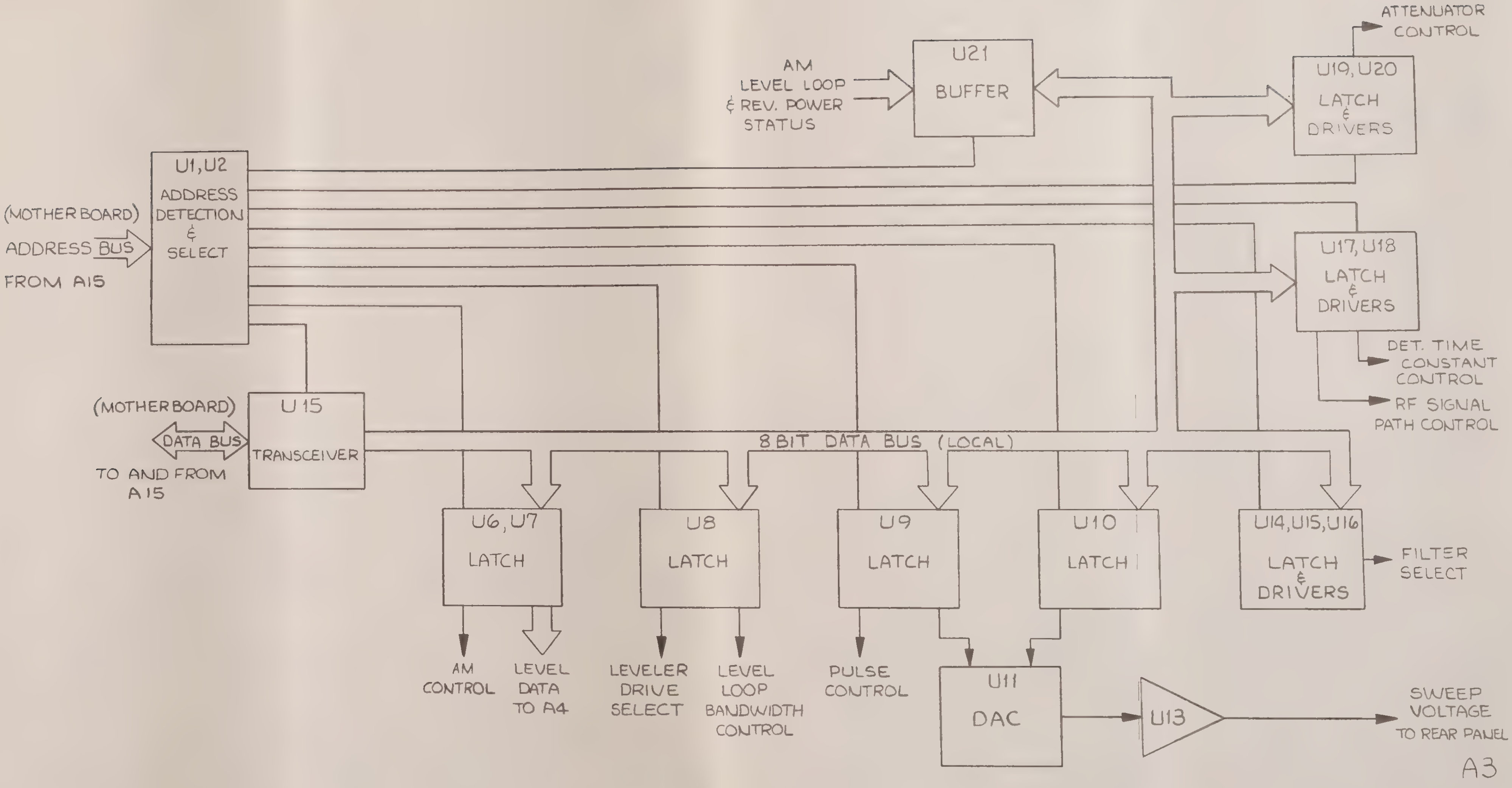
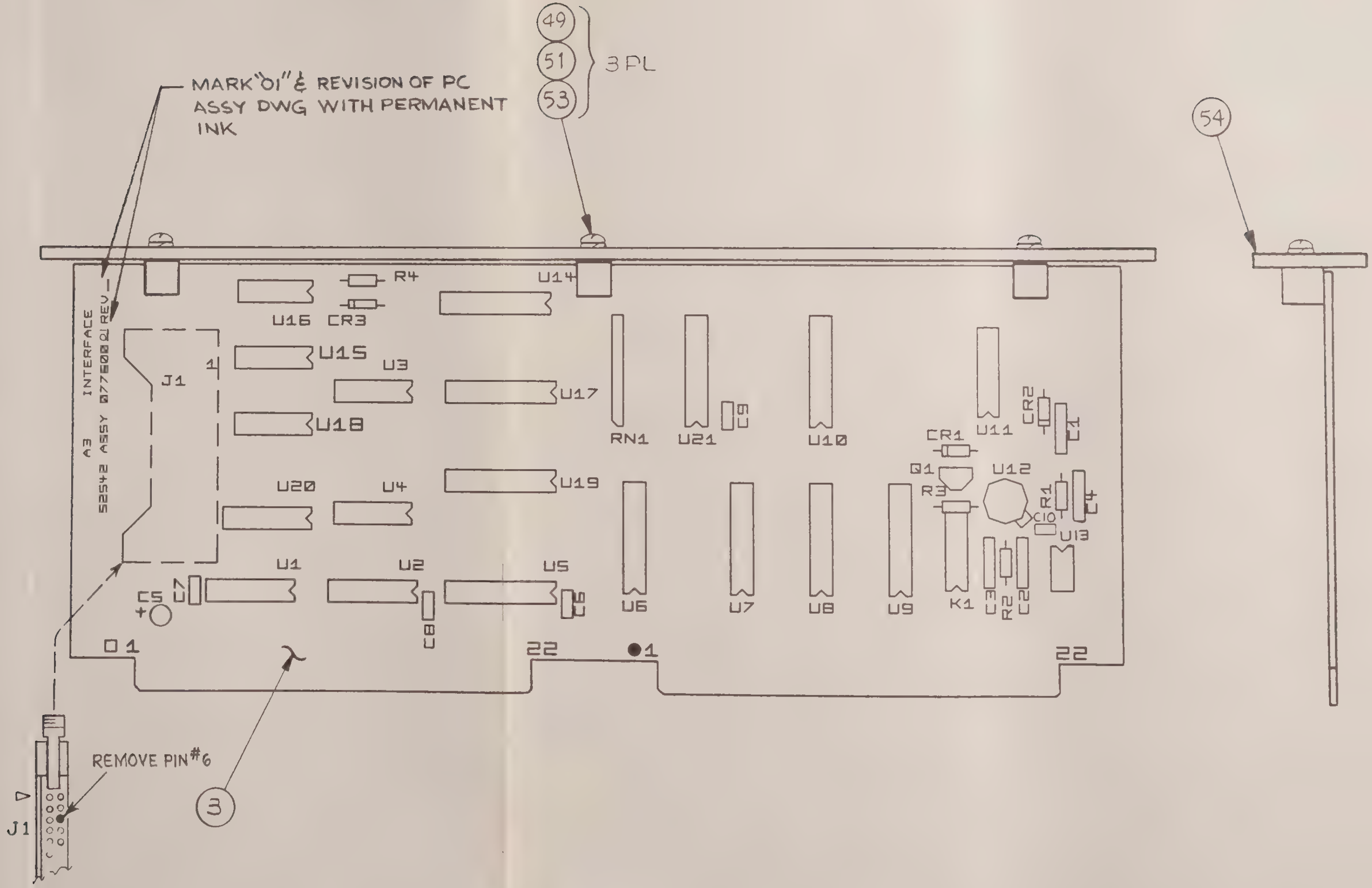

TO ENCODER
HP QEDS
7501/7594
J10
PHASE A
PHASE B
+5V
GND
2,7,9
3,6,10
4,5
N.C.
C32
.01
C33
.01
+5V
U60
MC14013
D
C
Q
R14
22K
C30
100pF
12
N.C
13
4,6,7,8,10
U61
MC14516
UP/DN COUNT
U62
MC14516
UP/DN COUNT
UP CLK
CI
CO
PE
R
Q0
Q1
Q2
Q3
+5V
N.C
U64
74LS221
R15
10K
R16
10K
CLR
RTCT
CT
C31
100pF
U63
74LS244
BUFFER
G
SPW
D0 D1 D2 D3
D0 D1 D2 D3
TO SH. 3

Figure 5-12. Keyboard and Display A1 and Front Panel Interface A2 Schematic (Sheet 8 of 8)



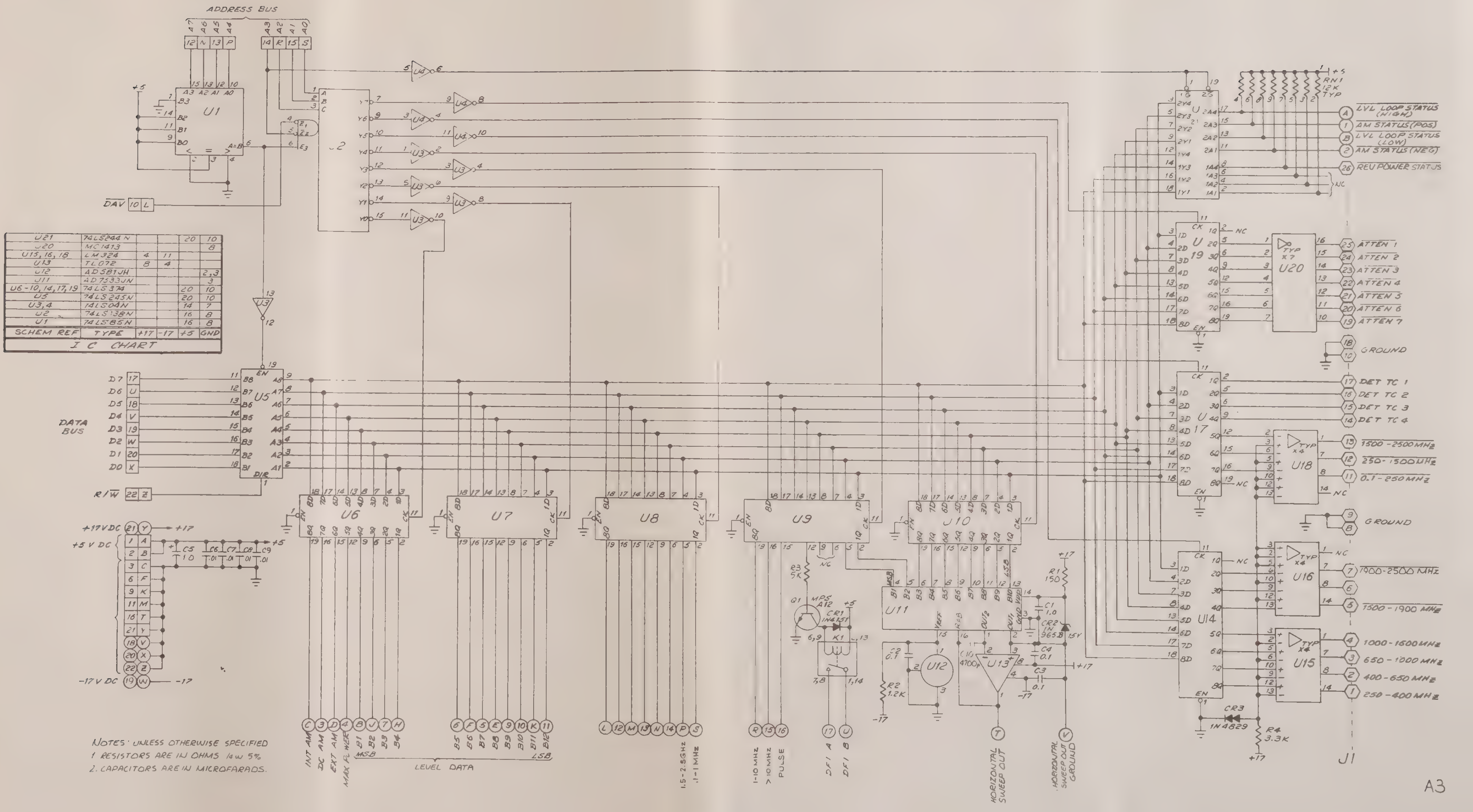
ATTENUATOR CONTROL
U21
BUFFER
AM LEVEL LOOP & REV. POWER STATUS
U19, U20
LATCH & DRIVERS
U1, U2
ADDRESS DETECTION & SELECT
(MOTHER BOARD)
ADDRESS BUS
FROM A15
U17, U18
LATCH & DRIVERS
DET. TIME CONSTANT CONTROL
RF SIGNAL PATH CONTROL
(MOTHER BOARD)
DATA BUS
TO AND FROM A15
U 15
TRANSCEIVER
8 BIT DATA BUS (LOCAL)
U6, U7
LATCH
U8
LATCH
U9
LATCH
U10
LATCH
U14, U15, U16
LATCH & DRIVERS
FILTER SELECT
AM CONTROL
LEVEL DATA TO A4
LEVELER DRIVE SELECT
LEVEL LOOP BANDWIDTH CONTROL
PULSE CONTROL
U11
DAC
U13
SWEEP VOLTAGE TO REAR PANEL
A3

Figure 5-13. Interface A3 Block Diagram



MARK "01" & REVISION OF PC ASSY DWG WITH PERMANENT INK
49
51
53
3 PL
54
A3 INTERFACE
52542 ASSY 077600 01 REV
R4
CR3
U14
U16
U15
U3
J1
1
U17
U18
U20
U4
U19
RN1
U21
C9
U10
U11
CR2
C1
CR1
Q1
U12
R3
R1
C4
C10
U13
U1
U2
U5
C5
+
C7
C8
C6
U6
U7
U8
U9
K1
C3
R2
C2
01
22
1
22
REMOVE PIN #6
J1
3

Figure 5-14. Interface PC Board Assembly A3


ADDRESS BUS
A7 A6 A5 A4 A3 A2 A1 A0
DAV
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
U14
U15
U16
U17
U18
U19
U20
U21
DATA BUS
D7 D6 D5 D4 D3 D2 D1 D0
R/W̄
+17VDC
+5 V DC
-17 V DC
C5 10
C6 .01
C7 .01
C8 .01
C9 .01
RN1 12K TYP
LVL LOOP STATUS (HIGH)
AM STATUS (POS)
LVL LOOP STATUS (LOW)
AM STATUS (NEG)
REV POWER STATUS
NC
ATTEN 1
ATTEN 2
ATTEN 3
ATTEN 4
ATTEN 5
ATTEN 6
ATTEN 7
GROUND
DET TC 1
DET TC 2
DET TC 3
DET TC 4
1500-2500 MHz
250-1500 MHz
0.1-250 MHz
1900-2500 MHz
1500-1900 MHz
1000-1500 MHz
650-1000 MHz
400-650 MHz
250-400 MHz
INT AM
DC AM
EXT AM
MAX PWR
B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12
MSB
LSB
LEVEL DATA
1.5-2.5GHz
.1-1MHz
1-10MHz
>10MHz
PULSE
R3 5K
Q1 MPS A12
CR1 1N4151
K1
DF1 A
DF1 B
C2 0.1
R2 1.2K
C10 4700p
C1 1.0
R1 150
CR2 1N965B 15V
C4 0.1
C3 0.1
HORIZONTAL SWEEP OUT
HORIZONTAL SWEEP OUT GROUND
CR3 1N4829
R4 3.3K
J1
A3

SCHEM REF	TYPE	+17	-17	+5	GND
U21	74LS244N			20	10
U20	MC1413				8
U15, 16, 18	LM324	4	11		
U13	TL072	8	4		
U12	AD581JH				2,3
U11	AD7533JN				3
U6-10, 14, 17, 19	74LS374			20	10
U5	74LS245N			20	10
U3, 4	74LS04N			14	7
U2	74LS138N			16	8
U1	74LS85N			16	8

I C CHART

NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS 1/4W 5%
2. CAPACITORS ARE IN MICROFARADS.

Figure 5-15. Interface A3 Schematic

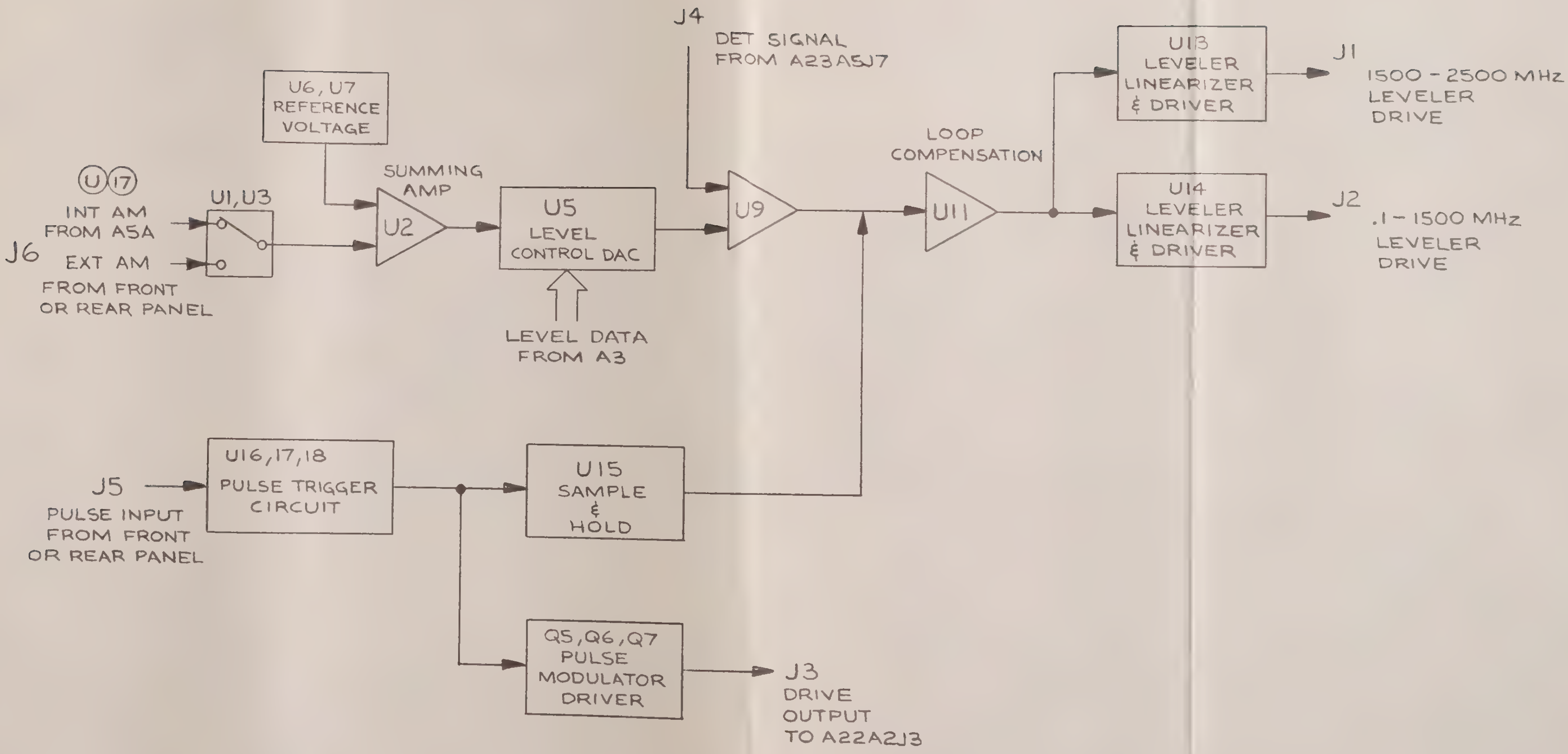
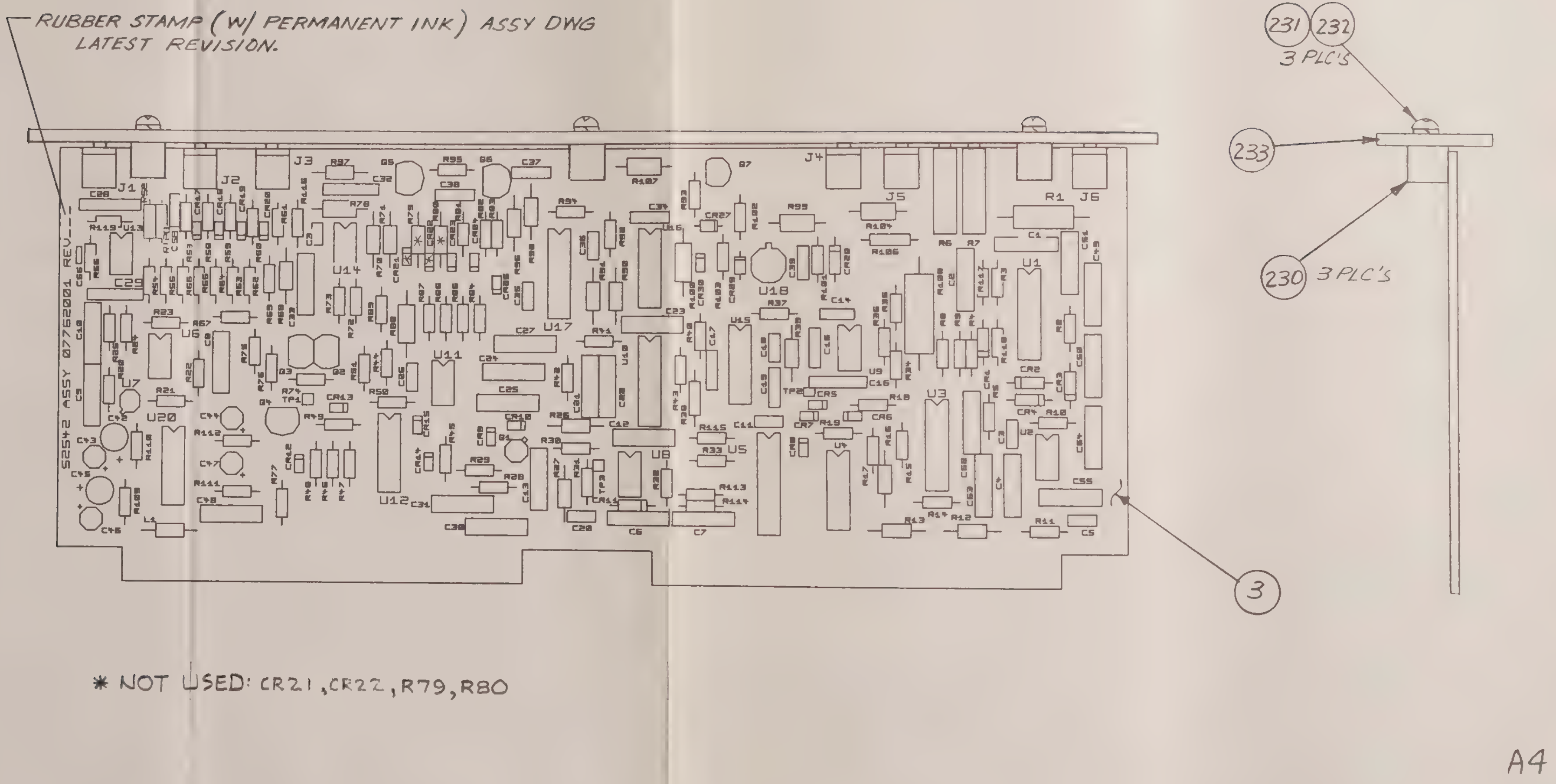

J4
DET SIGNAL
FROM A23A5J7
U6, U7
REFERENCE
VOLTAGE
U13
LEVELER
LINEARIZER
& DRIVER
J1
1500 - 2500 MHz
LEVELER
DRIVE
LOOP
COMPENSATION
SUMMING
AMP
U17
U1, U3
INT AM
FROM A5A
J6
EXT AM
FROM FRONT
OR REAR PANEL
U2
U5
LEVEL
CONTROL DAC
U9
U11
U14
LEVELER
LINEARIZER
& DRIVER
J2
.1 - 1500 MHz
LEVELER
DRIVE
LEVEL DATA
FROM A3
U16, 17, 18
PULSE TRIGGER
CIRCUIT
J5
PULSE INPUT
FROM FRONT
OR REAR PANEL
U15
SAMPLE
&
HOLD
Q5, Q6, Q7
PULSE
MODULATOR
DRIVER
J3
DRIVE
OUTPUT
TO A22A2J3
A4

Figure 5-16. Level Control A4 Block Diagram


RUBBER STAMP (W/ PERMANENT INK) ASSY DWG
LATEST REVISION.
52542 ASSY 07762001 REV__
J1
J2
J3
J4
J5
J6
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
U14
U15
U16
U17
U18
U20
231
232
3 PLC'S
233
230
3 PLC'S
3
A4

* NOT USED: CR21, CR22, R79, R80

Figure 5-17. Level Control PC Board Assembly A4

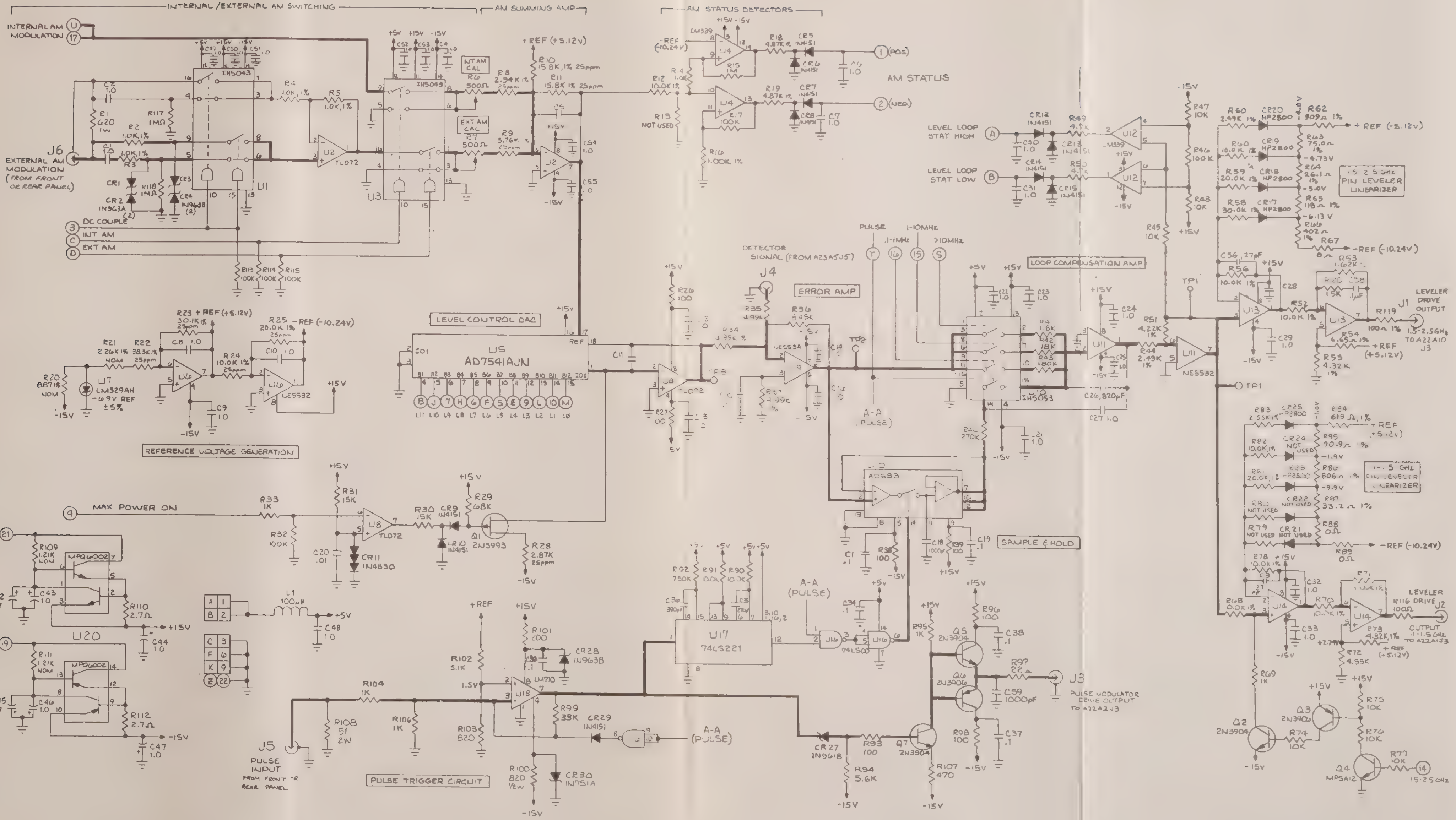

INTERNAL/EXTERNAL AM SWITCHING
AM SUMMING AMP
AM STATUS DETECTORS
INTERNAL AM MODULATION
EXTERNAL AM MODULATION (FROM FRONT OR REAR PANEL)
J6
DC COUPLE
INT AM
EXT AM
IH5043
U1
U2
TL072
U3
INT AM CAL
EXT AM CAL
+REF (+5.12V)
-REF (-10.24V)
LM339
U4
AM STATUS
(POS)
(NEG)
R13 NOT USED
LEVEL LOOP STAT HIGH
LEVEL LOOP STAT LOW
U12
.5-2.5 GHz PIN LEVELER LINEARIZER
LEVEL CONTROL DAC
U5
AD7541AJN
REFERENCE VOLTAGE GENERATION
U7
LM329AH
-6.9V REF ±5%
U6
NE5532
DETECTOR SIGNAL (FROM A23A5J5)
J4
ERROR AMP
PULSE
.1-1MHz
1-10MHz
>10MHz
LOOP COMPENSATION AMP
IH5053
U11
NE5532
TP1
TP2
TP3
U13
LEVELER DRIVE OUTPUT
J1
1.5-2.5GHz TO A22A10 J3
A-A (PULSE)
AD583
SAMPLE & HOLD
.1-1.5 GHz PIN LEVELER LINEARIZER
U14
LEVELER DRIVE
J2
OUTPUT .1-1.5GHz TO A22A1J3
MAX POWER ON
U8
TL072
Q1
2N3993
CR11
1N4830
MPQ6002
U20
+17V
-17V
L1
100μH
U17
74LS221
U16
74LS00
Q5
2N3904
Q6
2N3906
J3
PULSE MODULATOR DRIVE OUTPUT TO A22A2J3
U18
LM710
Q7
2N3904
J5
PULSE INPUT FROM FRONT OR REAR PANEL
PULSE TRIGGER CIRCUIT
CR30
1N751A
Q2
2N3904
Q3
2N3906
Q4
MPSA12
1.5-2.5 GHz

Figure 5-18. Level Control A4 Schematic

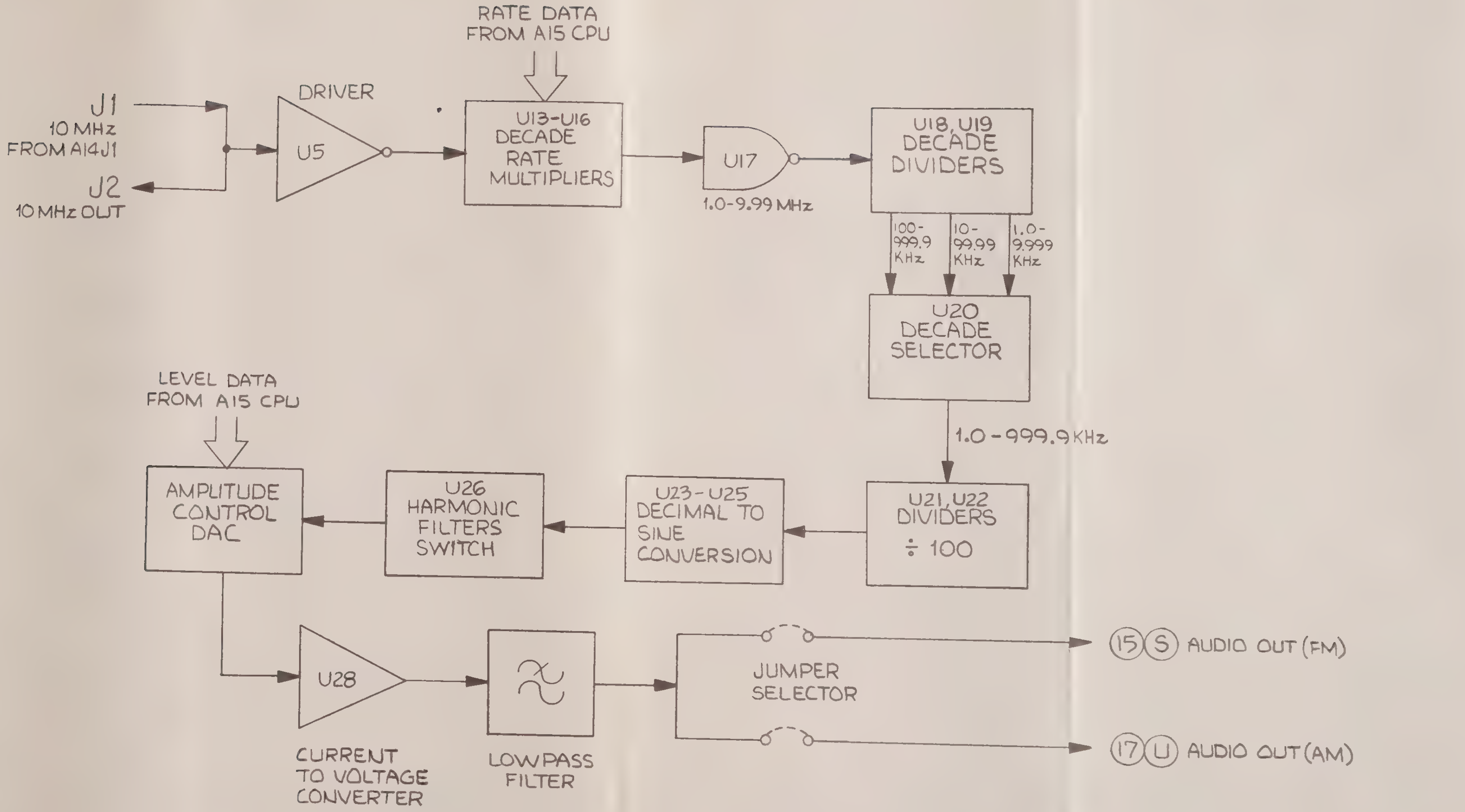
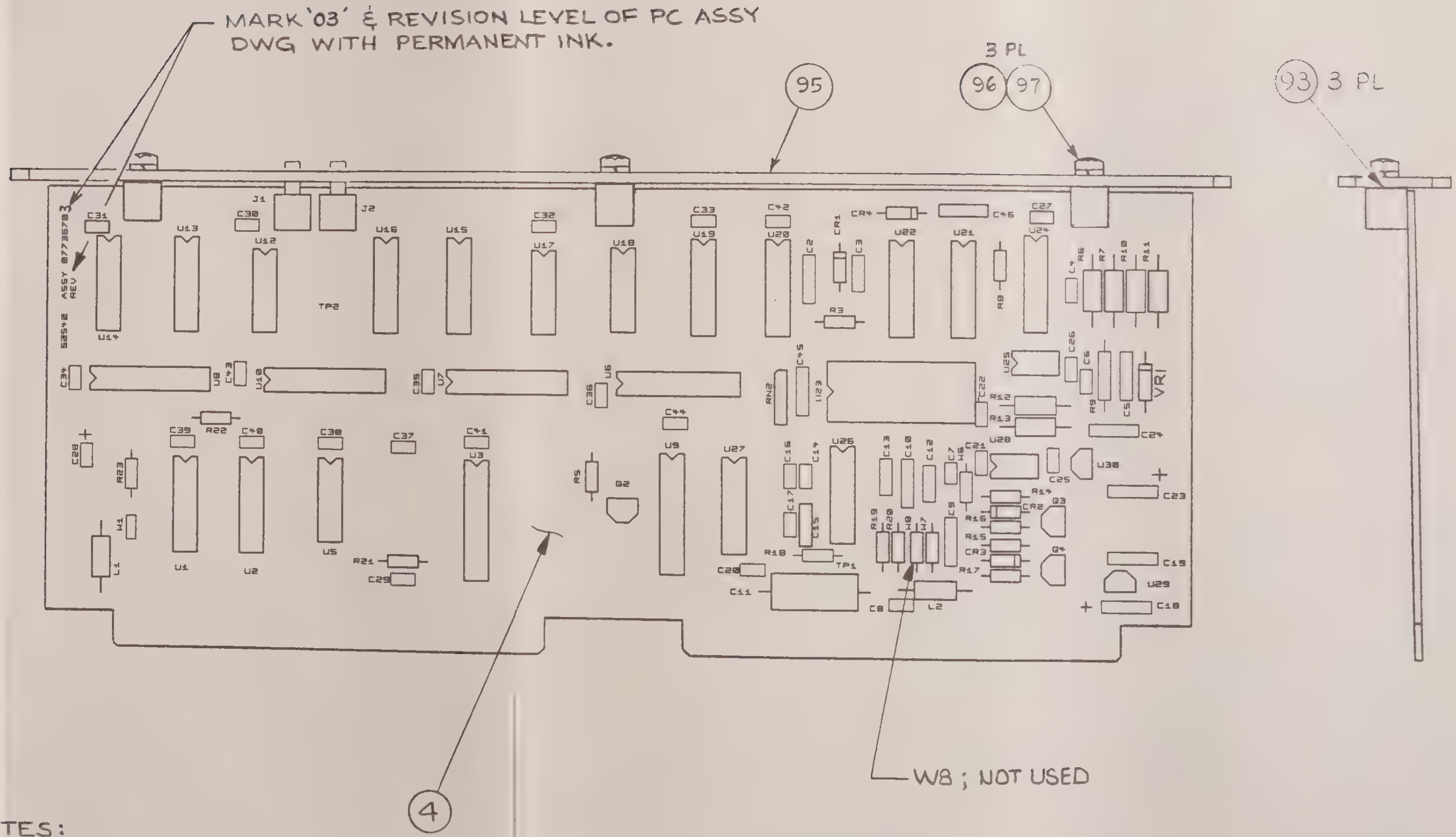

RATE DATA
FROM A15 CPU
J1
10 MHz
FROM A14J1
J2
10 MHz OUT
DRIVER
U5
U13-U16
DECADE
RATE
MULTIPLIERS
U17
1.0-9.99 MHz
U18, U19
DECADE
DIVIDERS
100-
999.9
KHz
10-
99.99
KHz
1.0-
9.999
KHz
U20
DECADE
SELECTOR
1.0 - 999.9 KHz
U21, U22
DIVIDERS
÷ 100
U23-U25
DECIMAL TO
SINE
CONVERSION
U26
HARMONIC
FILTERS
SWITCH
LEVEL DATA
FROM A15 CPU
AMPLITUDE
CONTROL
DAC
U28
CURRENT
TO VOLTAGE
CONVERTER
LOWPASS
FILTER
JUMPER
SELECTOR
⑮ Ⓢ AUDIO OUT (FM)
⑰ Ⓤ AUDIO OUT (AM)
A5

Figure 5-19. Audio Synthesizer A5 Block Diagram


3 PL
95
96
97
93
3 PL
4
ASSY 07736703
REV
52542
J1
J2
TP1
TP2
U1
U2
U3
U5
U6
U7
U8
U9
U10
U12
U13
U14
U15
U16
U17
U18
U19
U20
U21
U22
U23
U24
U25
U26
U27
U28
U29
U30
RN2
VR1
Q2
Q3
Q4
CR1
CR2
CR3
CR4
L1
L2
W1
W7
W8
W9

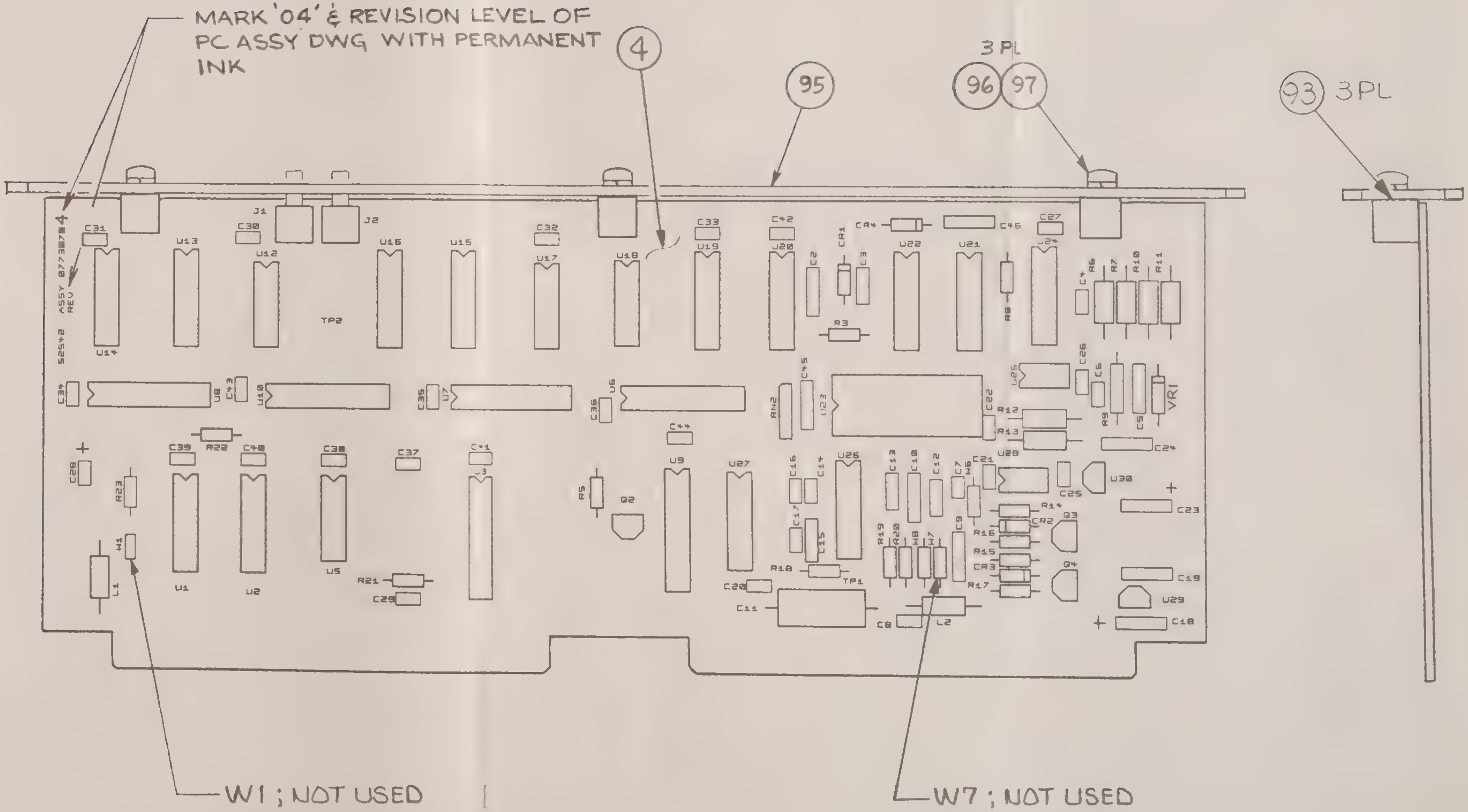
MARK '03' & REVISION LEVEL OF PC ASSY DWG WITH PERMANENT INK.

W8 ; NOT USED

NOTES:

1) USE GLASS BEADS ONLY ON CAPS WHOSE LEADS ARE BENT.

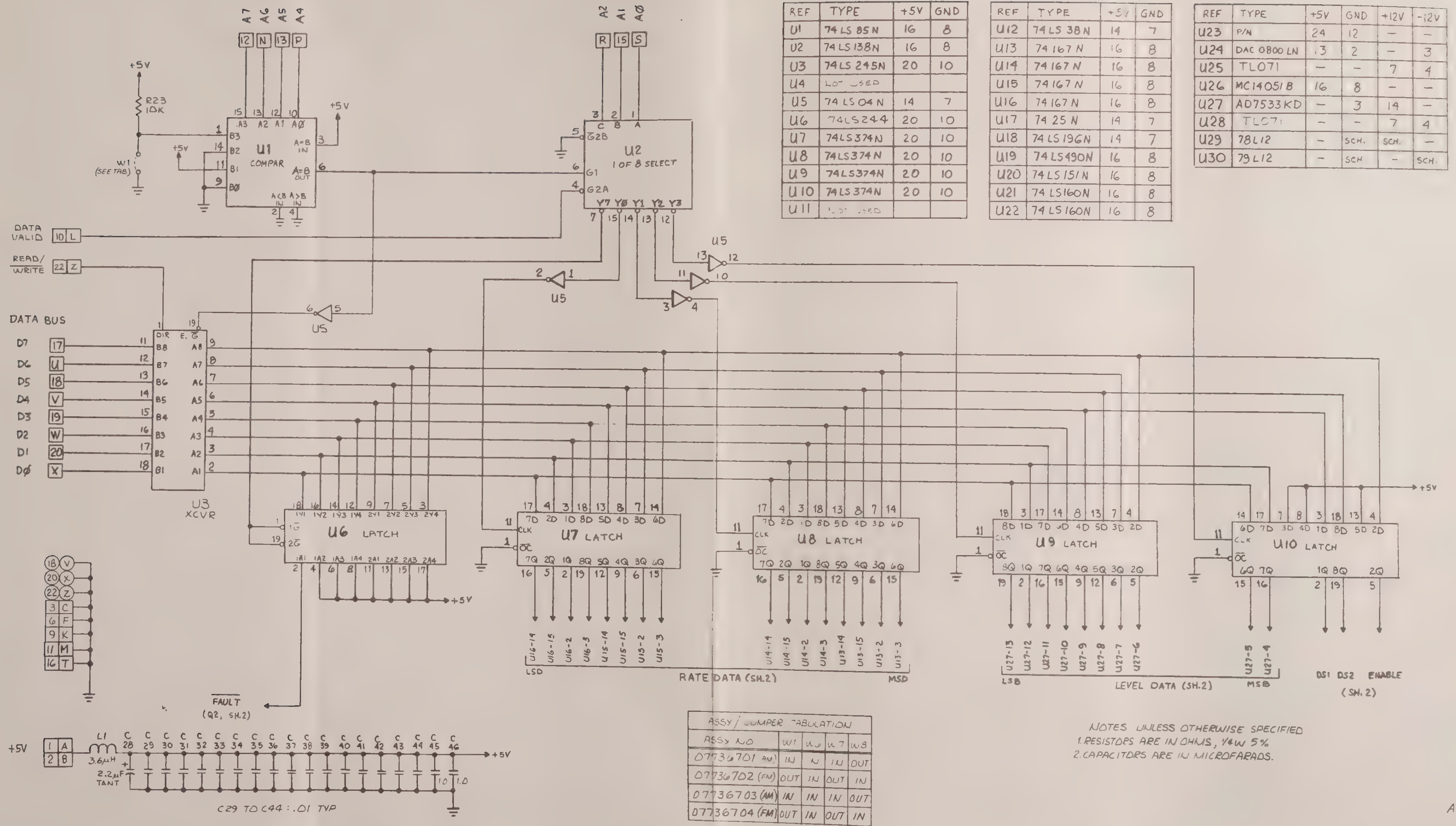
Figure 5-20. AM Audio Synthesizer PC Board Assembly A5A


MARK '04' & REVISION LEVEL OF PC ASSY DWG WITH PERMANENT INK
4
95
3 PL
96
97
93
3 PL
ASSY 0773▒▒-04
REV
525+2
J1
J2
C31
C30
C32
C33
C42
CR4
C46
C27
U13
U12
U16
U15
U17
U18
U19
U20
C2
CR1
C3
U22
U21
U24
C4
R6
R7
R10
R11
U14
TP2
R3
R8
C34
C43
U8
U10
C35
U7
C36
U6
RN2
C45
U23
C22
U25
C26
C6
R9
C5
VR1
R12
R13
C24
C44
C39
R22
C40
C38
C37
C41
U3
U9
U27
C16
C14
U26
C13
C10
C12
C7
W6
C21
U28
C25
U30
C23
C28
R23
R5
Q2
C17
C15
R14
CR2
Q3
R16
R15
CR3
R17
Q4
R19
R20
W8
W7
C9
W1
L1
U1
U2
U5
R21
C29
R18
TP1
C20
C11
C8
L2
C19
U29
C18
+
W1 ; NOT USED
W7 ; NOT USED

NOTES:

1) USE GLASS BEADS ONLY ON CAPS WHOSE LEADS ARE BENT.

Figure 5-21. FM Audio Synthesizer PC Board Assembly A5B


A7
A6
A5
A4
12
N
13
P
A2
A1
A0
R
15
S
+5V
R23
10K
W1
(SEE TAB)
U1
COMPAR
A=B IN
A=B OUT
A<B IN
A>B IN
B3
B2
B1
B0
U2
1 OF 8 SELECT
G2B
G1
G2A
Y7
Y0
Y1
Y2
Y3
DATA VALID
10
L
READ/WRITE
22
Z
DATA BUS
D7
17
D6
U
D5
18
D4
V
D3
19
D2
W
D1
20
D0
X
U3
XCVR
DIR
E. G
U5
U6 LATCH
U7 LATCH
U8 LATCH
U9 LATCH
U10 LATCH
CLK
OC
+5V
U16-14
U16-15
U16-2
U16-3
U15-14
U15-15
U15-2
U15-3
U14-14
U14-15
U14-2
U14-3
U13-14
U13-15
U13-2
U13-3
LSD
RATE DATA (SH.2)
MSD
U27-13
U27-12
U27-11
U27-10
U27-9
U27-8
U27-7
U27-6
U27-5
U27-4
LSB
LEVEL DATA (SH.2)
MSB
DS1
DS2
ENABLE
(SH.2)
FAULT
(Q2, SH.2)
18 V
20 X
22 Z
3 C
6 F
9 K
11 M
16 T
+5V
1 A
2 B
L1
3.6μH
2.2μF TANT
C28
C29
C30
C31
C32
C33
C34
C35
C36
C37
C38
C39
C40
C41
C42
C43
C44
C45
C46
10
1.0
C29 TO C44 : .01 TYP
A5

REF	TYPE	+5V	GND
U1	74 LS 85 N	16	8
U2	74 LS 138N	16	8
U3	74 LS 245N	20	10
U4	NOT USED		
U5	74 LS 04 N	14	7
U6	74LS244	20	10
U7	74LS374N	20	10
U8	74LS374N	20	10
U9	74LS374N	20	10
U10	74LS374N	20	10
U11	NOT USED		

REF	TYPE	+5V	GND
U12	74 LS 38 N	14	7
U13	74 167 N	16	8
U14	74 167 N	16	8
U15	74 167 N	16	8
U16	74 167 N	16	8
U17	74 25 N	14	7
U18	74 LS 196N	14	7
U19	74 LS 490N	16	8
U20	74 LS 151 N	16	8
U21	74 LS 160N	16	8
U22	74 LS 160N	16	8

REF	TYPE	+5V	GND	+12V	-12V
U23	P/N	24	12	—	—
U24	DAC 0800 LN	13	2	—	3
U25	TL071	—	—	7	4
U26	MC14051B	16	8	—	—
U27	AD7533KD	—	3	14	—
U28	TL071	—	—	7	4
U29	78L12	—	SCH.	SCH.	—
U30	79L12	—	SCH	—	SCH.

ASSY/JUMPER TABULATION				
ASSY NO	W1	W6	W7	W8
07736701 (AM)	IN	IN	IN	OUT
07736702 (FM)	OUT	IN	OUT	IN
07736703 (AM)	IN	IN	IN	OUT
07736704 (FM)	OUT	IN	OUT	IN

NOTES UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS, 1/4W 5%
2. CAPACITORS ARE IN MICROFARADS.

Figure 5-22. Audio Synthesizer A5 Schematic (Sheet 1 of 2)

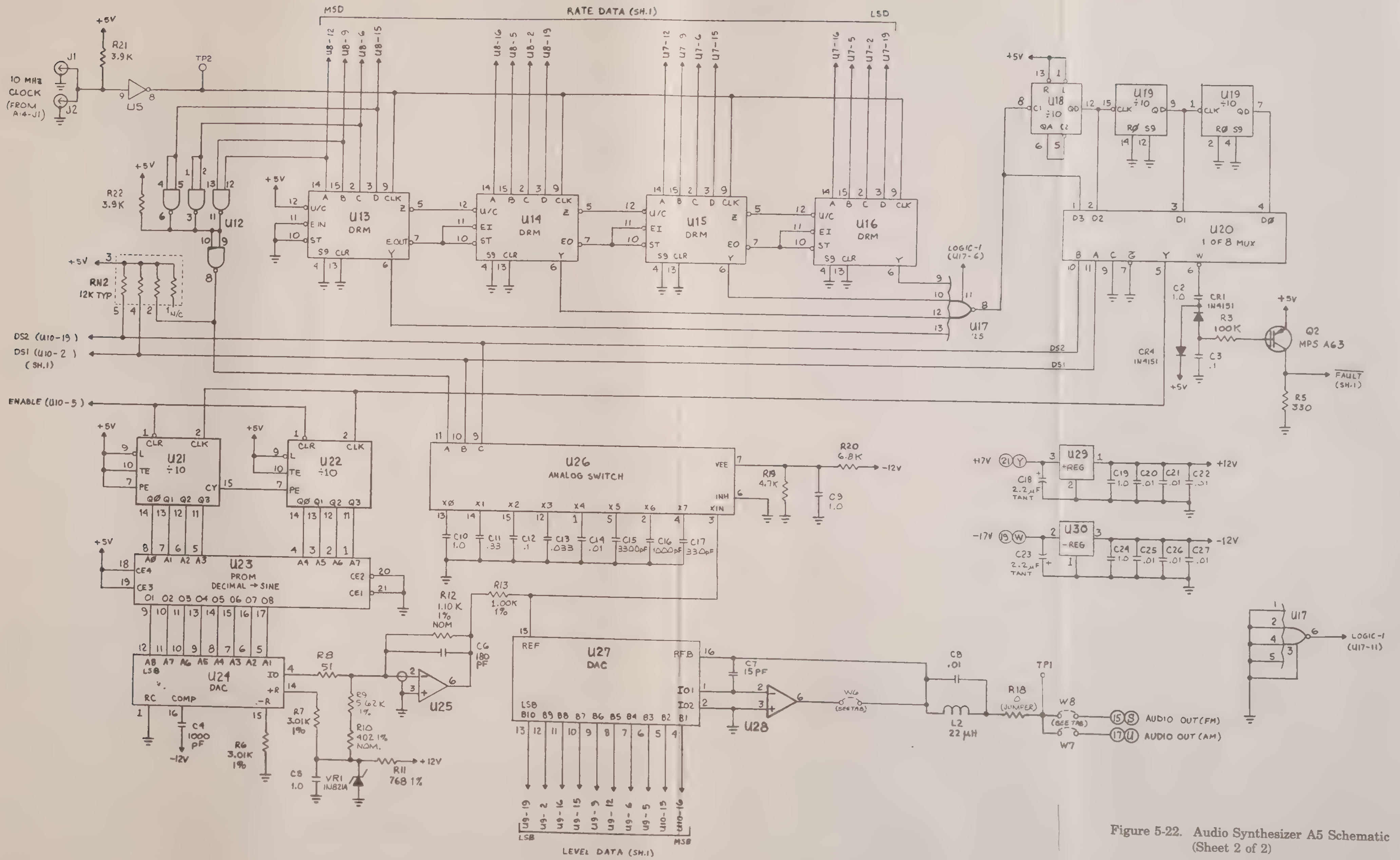
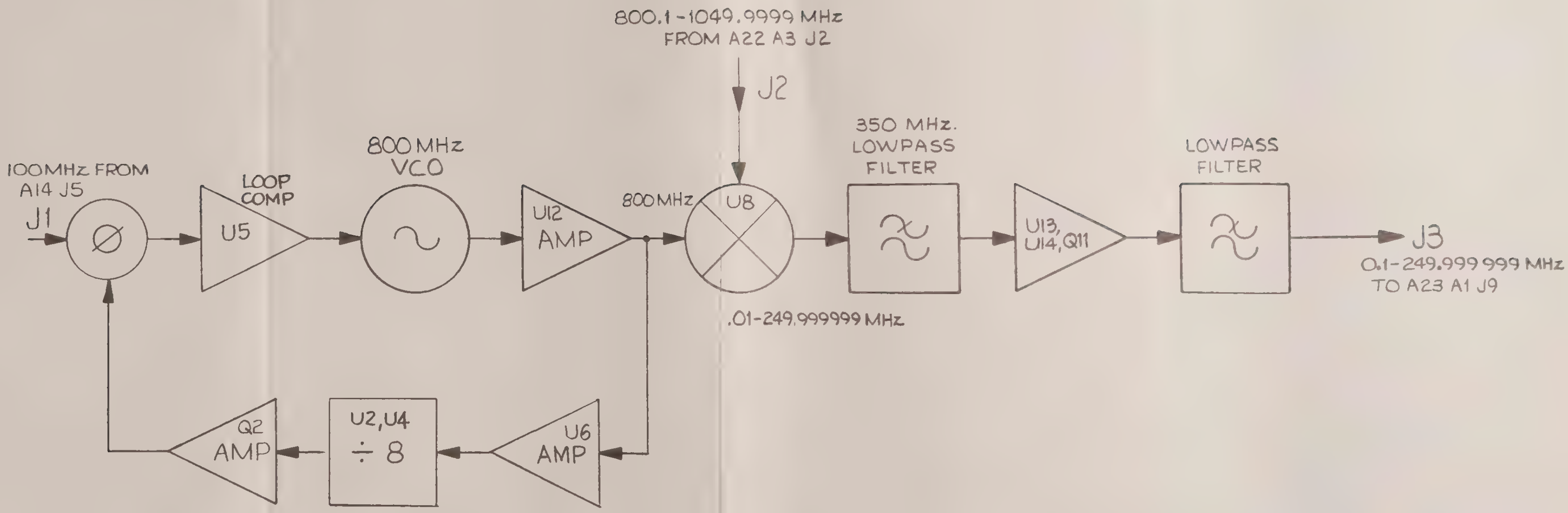

RATE DATA (SH.1)
MSD
LSD
U8-12 U8-9 U8-6 U8-15
U8-16 U8-5 U8-2 U8-19
U7-12 U7-9 U7-6 U7-15
U7-16 U7-5 U7-2 U7-19
+5V
R21 3.9K
J1
J2
TP2
10 MHz CLOCK (FROM A14-J1)
U5
R22 3.9K
U12
RN2 12K TYP
N/C
U13 DRM
U14 DRM
U15 DRM
U16 DRM
U/C EIN ST S9 CLR EOUT
LOGIC-1 (U17-6)
U17 '25
U18 ÷10
U19 ÷10
U20 1 OF 8 MUX
D3 D2 D1 D0
C2 1.0
CR1 1N4151
R3 100K
Q2 MPS A63
CR4 1N4151
C3 .1
FAULT (SH.1)
R5 330
DS2 (U10-19)
DS1 (U10-2) (SH.1)
DS2
DS1
ENABLE (U10-5)
U21 ÷10
U22 ÷10
CLR CLK L TE PE CY Q0 Q1 Q2 Q3
U26 ANALOG SWITCH
VEE INH XIN
X0 X1 X2 X3 X4 X5 X6 X7
R19 4.7K
R20 6.8K
-12V
C9 1.0
C10 1.0
C11 .33
C12 .1
C13 .033
C14 .01
C15 3300pF
C16 1000pF
C17 330pF
U23 PROM DECIMAL → SINE
CE4 CE3 CE2 CE1
A0 A1 A2 A3 A4 A5 A6 A7
O1 O2 O3 O4 O5 O6 O7 O8
U24 DAC
LSB RC COMP IO +R -R
C4 1000 pF
R6 3.01K 1%
R7 3.01K 1%
C5 1.0
VR1 1N821A
R8 51
R9 5.62K 1%
R10 402 1% NOM.
R11 768 1%
+12V
R12 1.10K 1% NOM
R13 1.00K 1%
C6 180 PF
U25
U27 DAC
REF RFB IO1 IO2
B10 B9 B8 B7 B6 B5 B4 B3 B2 B1
U9-19 U9-2 U9-16 U9-15 U9-9 U9-12 U9-6 U9-5 U10-15 U10-16
LSB
MSB
LEVEL DATA (SH.1)
C7 15PF
U28
W6 (SEE TAB)
C8 .01
L2 22 µH
TP1
R18 0 (JUMPER)
W8 (SEE TAB)
W7
15 S AUDIO OUT (FM)
17 U AUDIO OUT (AM)
+17V 21 Y
U29 +REG
C18 2.2µF TANT
C19 1.0
C20 .01
C21 .01
C22 .01
+12V
-17V 19 W
U30 -REG
C23 2.2µF TANT
C24 1.0
C25 .01
C26 .01
C27 .01
-12V
U17
LOGIC-1 (U17-11)

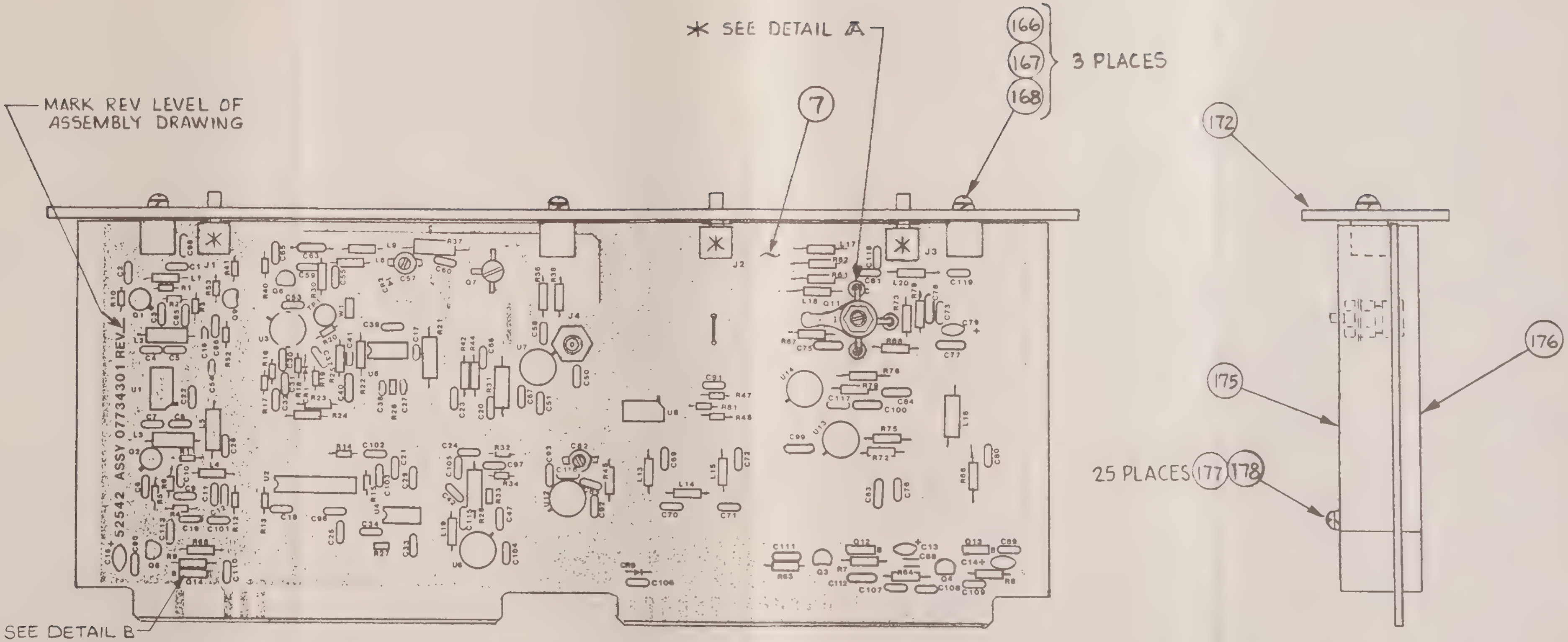
Figure 5-22. Audio Synthesizer A5 Schematic (Sheet 2 of 2)



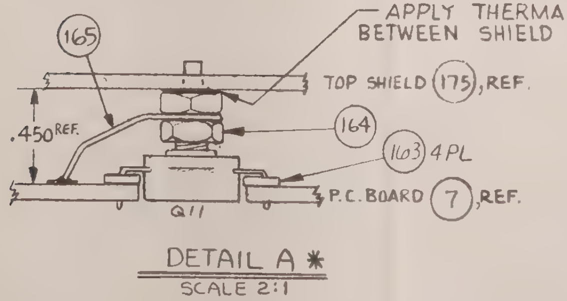
800.1-1049.9999 MHz
FROM A22 A3 J2
J2
100MHz FROM
A14 J5
J1
Ø
LOOP
COMP
U5
800 MHz
VCO
U12
AMP
800 MHz
U8
350 MHz.
LOWPASS
FILTER
U13,
U14, Q11
LOWPASS
FILTER
J3
0.1-249.999 999 MHz
TO A23 A1 J9
.01-249.999999 MHz
Q2
AMP
U2, U4
÷ 8
U6
AMP

A6

Figure 5-23. Downconverter A6 Block Diagram



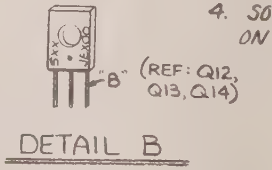
* SEE DETAIL A
166
167
168
3 PLACES
7
MARK REV LEVEL OF ASSEMBLY DRAWING
52542 ASSY 07734301 REV
J1
J2
J3
J4
Q11
172
176
175
25 PLACES 177 178
SEE DETAIL B



165
APPLY THERMAL COMPOUND BETWEEN SHIELD & HEX NUT
TOP SHIELD 175, REF.
.450 REF.
164
163 4 PL
P.C. BOARD 7, REF.
Q11

DETAIL A *

SCALE 2:1



5xx
"B"
(REF: Q12, Q13, Q14)

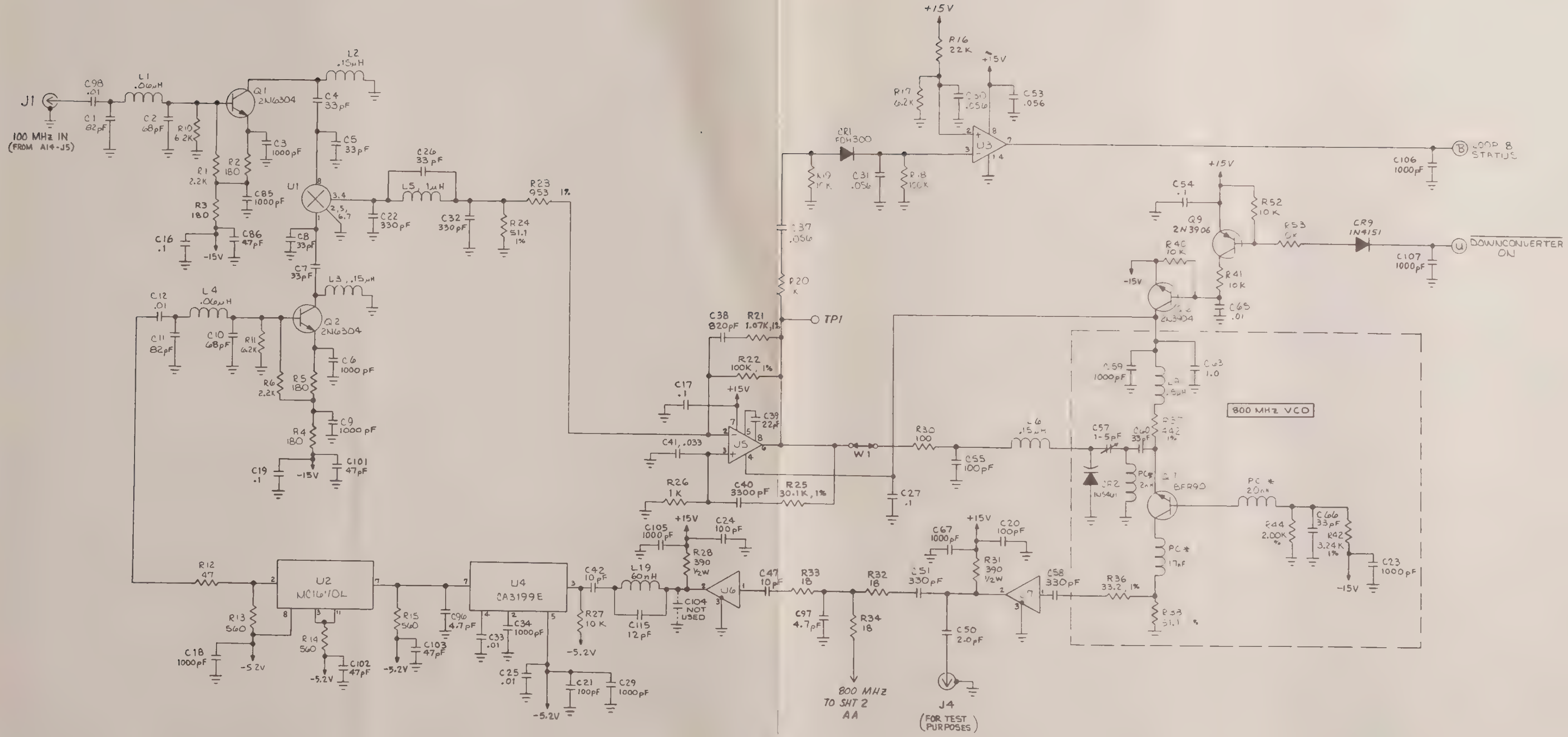
DETAIL B

NOTES:

1. *USE GLASS BEADS ONLY ON CAPS WHOSE LEADS ARE BENT.*
2. *ON CIRCUIT SIDE TRIM PINS ON J1 → J4 .*
3. ** DENOTES AFTER FLOW SOLDER PARTS .*
4. *SOLDERMASK ENTIRE GOLD-PLATED OUTLINE OF SHIELD ON SOLDER SIDE OF P.C. BOARD BEFORE LOADING .* (176)

A6

Figure 5-24. Downconverter PC Board Assembly A6

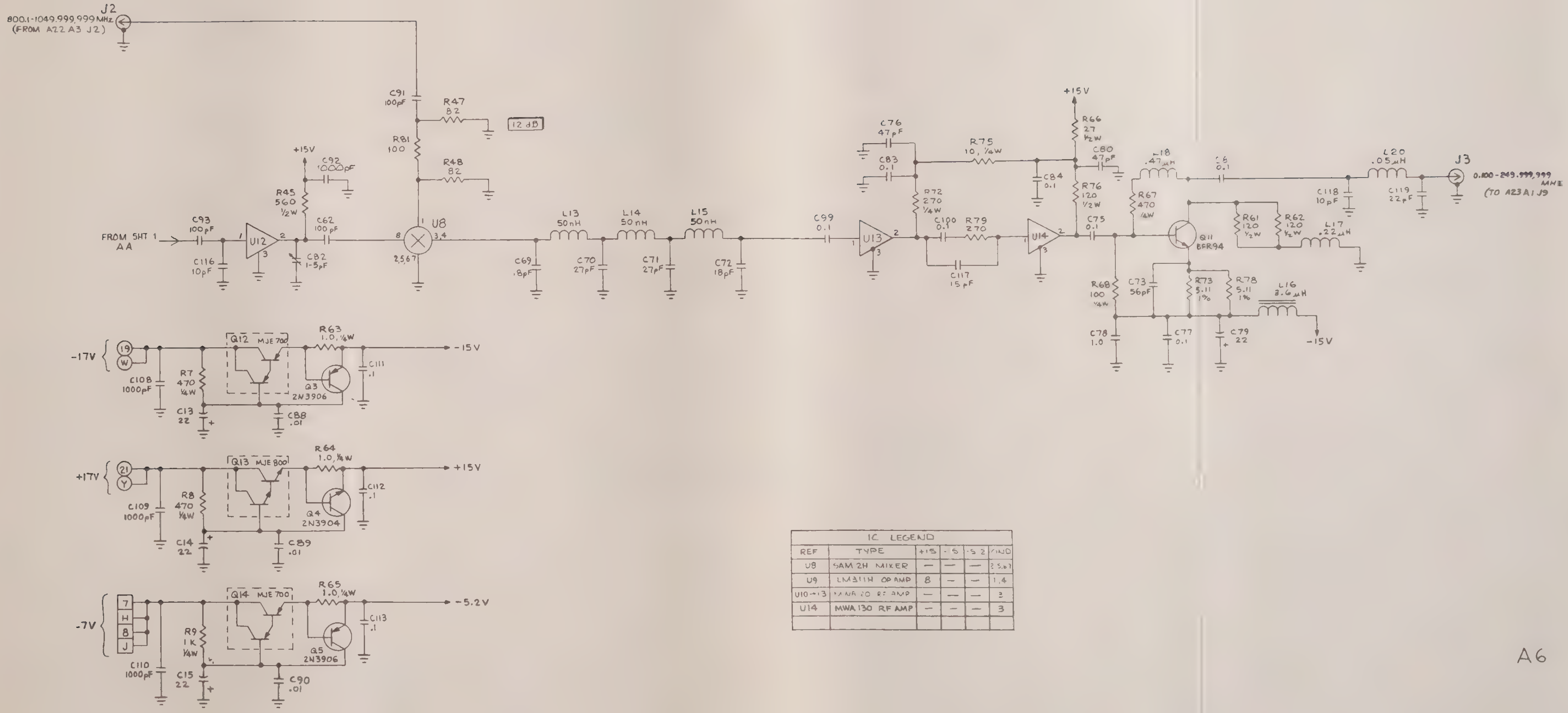

J1
100 MHz IN (FROM A14-J5)
C98 .01
L1 .06µH
C1 82pF
C2 68pF
R10 6.2K
Q1 2N6304
L2 .15µH
C4 33pF
C5 33pF
C3 1000pF
R1 2.2K
R2 180
R3 180
C85 1000pF
C16 .1
-15V
C86 47pF
U1
C8 33pF
C7 33pF
C22 330pF
C26 33pF
L5 1µH
C32 330pF
R23 953 1%
R24 51.1 1%
L3 .15µH
C12 .01
L4 .06µH
C11 82pF
C10 68pF
R11 6.2K
Q2 2N6304
C6 1000pF
R6 2.2K
R5 180
C9 1000pF
R4 180
C19 .1
-15V
C101 47pF
R12 47
U2 MC16'10L
R13 560
C18 1000pF
-5.2V
R14 560
C102 47pF
R15 560
C96 4.7pF
C103 47pF
U4 CA3199E
C33 .01
C34 1000pF
C25 .01
C21 100pF
C29 1000pF
-5.2V
C42 10pF
R27 10K
L19 60nH
C115 12pF
C105 1000pF
+15V
R28 390 ½W
C24 100pF
C104 NOT USED
U6
C47 10pF
R33 18
C97 4.7pF
R34 18
800 MHz TO SHT 2 AA
R32 18
C51 330pF
C50 2.0pF
J4 (FOR TEST PURPOSES)
C67 1000pF
+15V
C20 100pF
R31 390 ½W
U7
C58 330pF
R36 33.2 1%
R38 51.1
C38 820pF
R21 1.07K 1%
R22 100K 1%
C17 .1
+15V
C39 22pF
U5
C41 .033
R26 1K
C40 3300pF
R25 30.1K 1%
TP1
W1
R30 100
C55 100pF
C27 .1
+15V
R16 22K
+15V
R17 6.2K
C30 .056
C53 .056
U3
CR1 FDH300
R19 10K
C31 .056
R18 150K
C37 .056
R20 K
C106 1000pF
B LOOP 8 STATUS
+15V
C54 .1
R52 10K
Q9 2N3906
R53 6K
CR9 1N4151
C107 1000pF
U DOWNCONVERTER ON
R40 10K
-15V
R41 10K
C65 .01
2N3904
800 MHz VCO
C59 1000pF
C63 1.0
L .15µH
R37 442 1%
C57 1-5pF
C60 33pF
CR2
Q1 BFR90
PC ✱ 20nH
R44 2.00K
C66 33pF
R42 3.24K 1%
C23 1000pF
-15V
PC ✱ 17nF

✱ LEGEND					
REF	TYPE	+15	-15	-5.2	GND
U	SAM 1 MIXER	—	—	—	2,5,6,7
U2	MC16'10L ÷ 2, ECL	—	—	8	1,16
U3	LM311H (OP AMP)	8	—	—	1,4
U4	CA3199E-4 ECL	—	—	—	8
U5	NE5534 OP AMP	—	—	—	—
U6,7	MWA120, RF AMP	—	—	—	3

NOTES: UNLESS OTHERWISE SPECIFIED.
1 RESISTORS ARE IN OHMS, 1/8 W 5% CC.
2. CAPACITORS ARE IN MICROFARADS.
3 ✱ DENOTES INDUCTORS WITHIN TRACE PATTERN.

A6

Figure 5-25. Downconverter A6 Schematic (Sheet 1 of 2)


J2
800.1-1049.999,999 MHz
(FROM A22 A3 J2)
C91 100pF
R47 82
12 dB
R81 100
R48 82
+15V
C92 1000pF
R45 560 ½W
C93 100pF
FROM SHT 1 AA
C116 10pF
U12
C62 100pF
C82 1-5pF
U8
2,5,6,7
3,4
C69 .8pF
L13 50nH
C70 27pF
L14 50nH
C71 27pF
L15 50nH
C72 18pF
C99 0.1
U13
C76 47pF
C83 0.1
R72 270 ¼W
C100 0.1
R79 270
C117 15pF
R75 10, ¼W
C84 0.1
U14
+15V
R66 27 ½W
C80 47pF
R76 120 ½W
C75 0.1
R68 100 ¼W
C73 56pF
C78 1.0
L18 .47µH
R67 470 ¼W
Q11 BFR94
C6 0.1
R61 120 ½W
R62 120 ½W
L17 .22µH
R73 5.11 1%
R78 5.11 1%
L16 3.6µH
C77 0.1
C79 22
-15V
C118 10pF
L20 .05µH
C119 22pF
J3
0.100-249.999,999 MHz
(TO A23A1 J9)
-17V
19
W
C108 1000pF
R7 470 ¼W
C13 22
Q12 MJE700
R63 1.0, ¼W
Q3 2N3906
C88 .01
C111 .1
-15V
+17V
21
Y
C109 1000pF
R8 470 ¼W
C14 22
Q13 MJE800
R64 1.0, ¼W
Q4 2N3904
C89 .01
C112 .1
+15V
-7V
7
H
8
J
C110 1000pF
R9 1K ¼W
C15 22
Q14 MJE700
R65 1.0, ¼W
Q5 2N3906
C90 .01
C113 .1
-5.2V
A6

IC LEGEND					
REF	TYPE	+15	-5	-5.2	GND
U8	SAM 2H MIXER	—	—	—	2,5,6,7
U9	LM311H OP AMP	8	—	—	1,4
U10→13	MWA 120 RF AMP	—	—	—	3
U14	MWA 130 RF AMP	—	—	—	3

Figure 5-25. Downconverter A6 Schematic (Sheet 2 of 2)

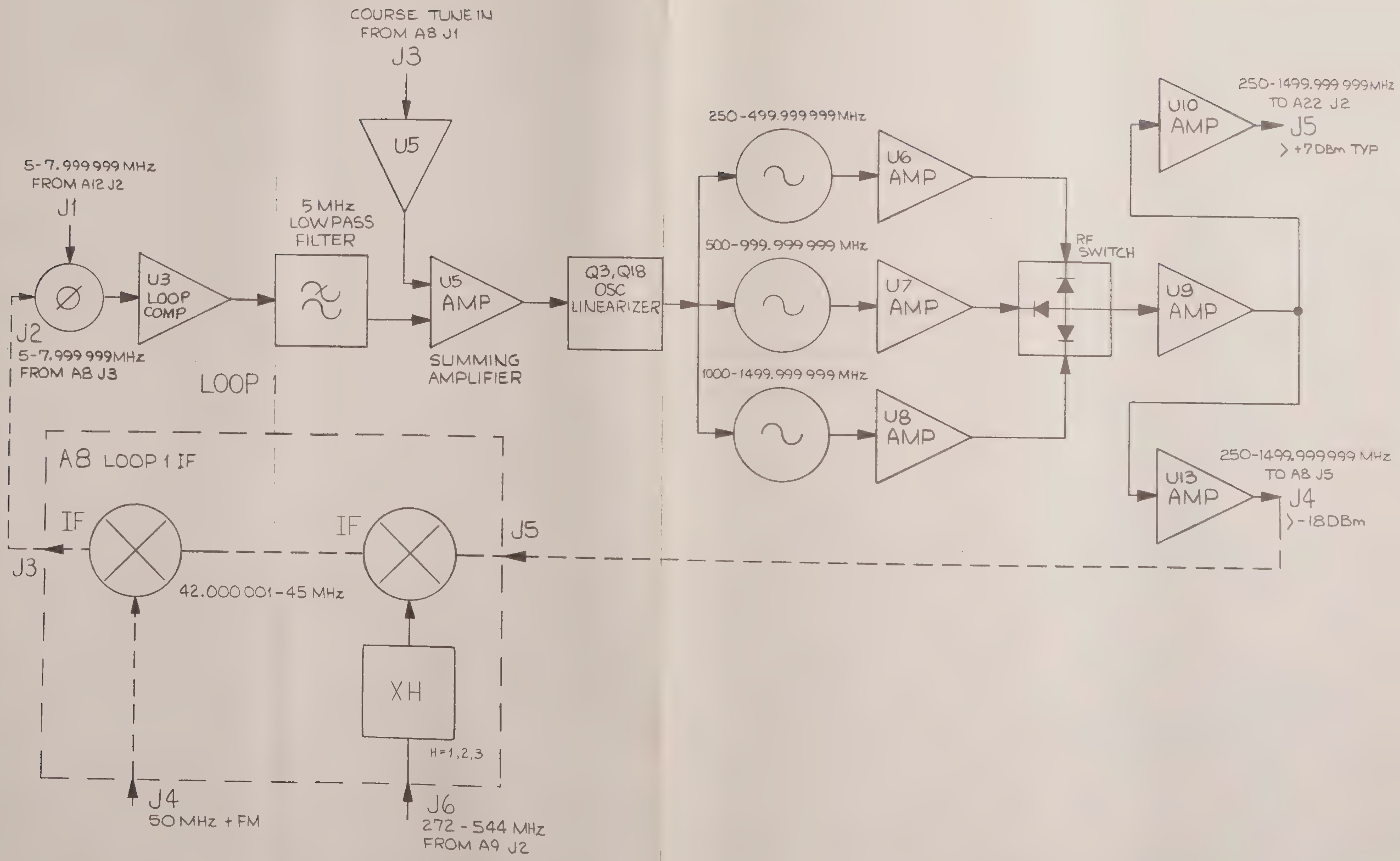
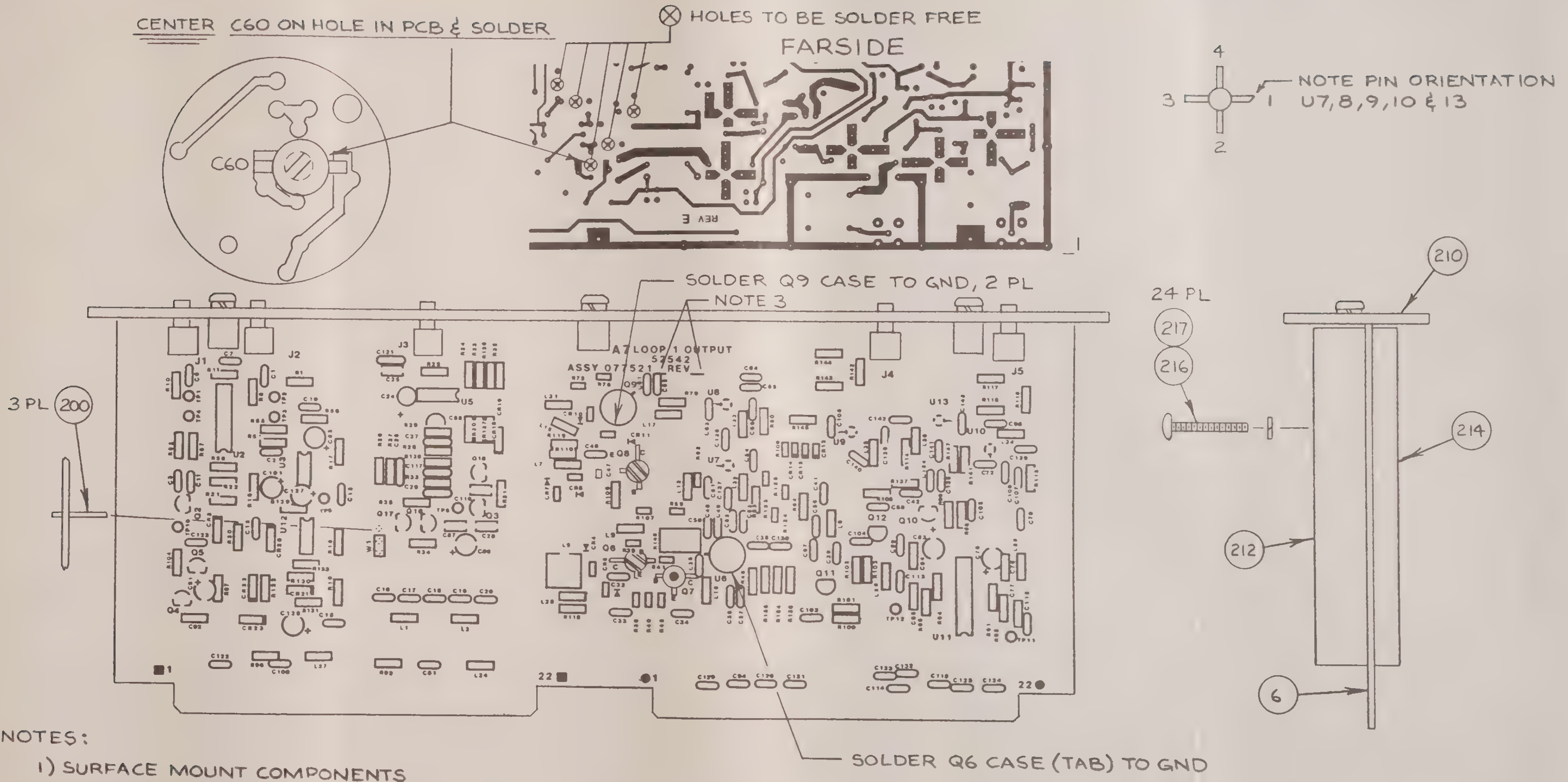

COURSE TUNE IN
FROM A8 J1
J3
U5
5-7.999 999 MHz
FROM A12 J2
J1
5 MHz
LOWPASS
FILTER
U3
LOOP
COMP
U5
AMP
SUMMING
AMPLIFIER
Q3, Q18
OSC
LINEARIZER
J2
5-7.999 999MHz
FROM A8 J3
LOOP 1
250-499.999 999 MHz
500-999.999 999 MHz
1000-1499.999 999 MHz
U6
AMP
U7
AMP
U8
AMP
RF
SWITCH
U9
AMP
U10
AMP
250-1499.999 999 MHz
TO A22 J2
J5
> +7 DBm TYP
U13
AMP
250-1499.999 999 MHz
TO A8 J5
J4
> -18 DBm
A8 LOOP 1 IF
IF
IF
J5
J3
42.000 001-45 MHz
XH
H=1,2,3
J4
50 MHz + FM
J6
272 - 544 MHz
FROM A9 J2

Figure 5-26. Loop 1 A7 Block Diagram


CENTER C60 ON HOLE IN PCB & SOLDER
C60
⊗ HOLES TO BE SOLDER FREE
FARSIDE
REV E
1
4
3
1
2
NOTE PIN ORIENTATION U7,8,9,10 & 13
SOLDER Q9 CASE TO GND, 2 PL
NOTE 3
A7 LOOP 1 OUTPUT
ASSY 077521 57542 REV
24 PL
210
217
216
214
212
6
3 PL
200
J1
J2
J3
J4
J5
U2
U5
U7
U8
U10
U11
U12
U13
Q3
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q17
1
22
1
22
SOLDER Q6 CASE (TAB) TO GND

NOTES:

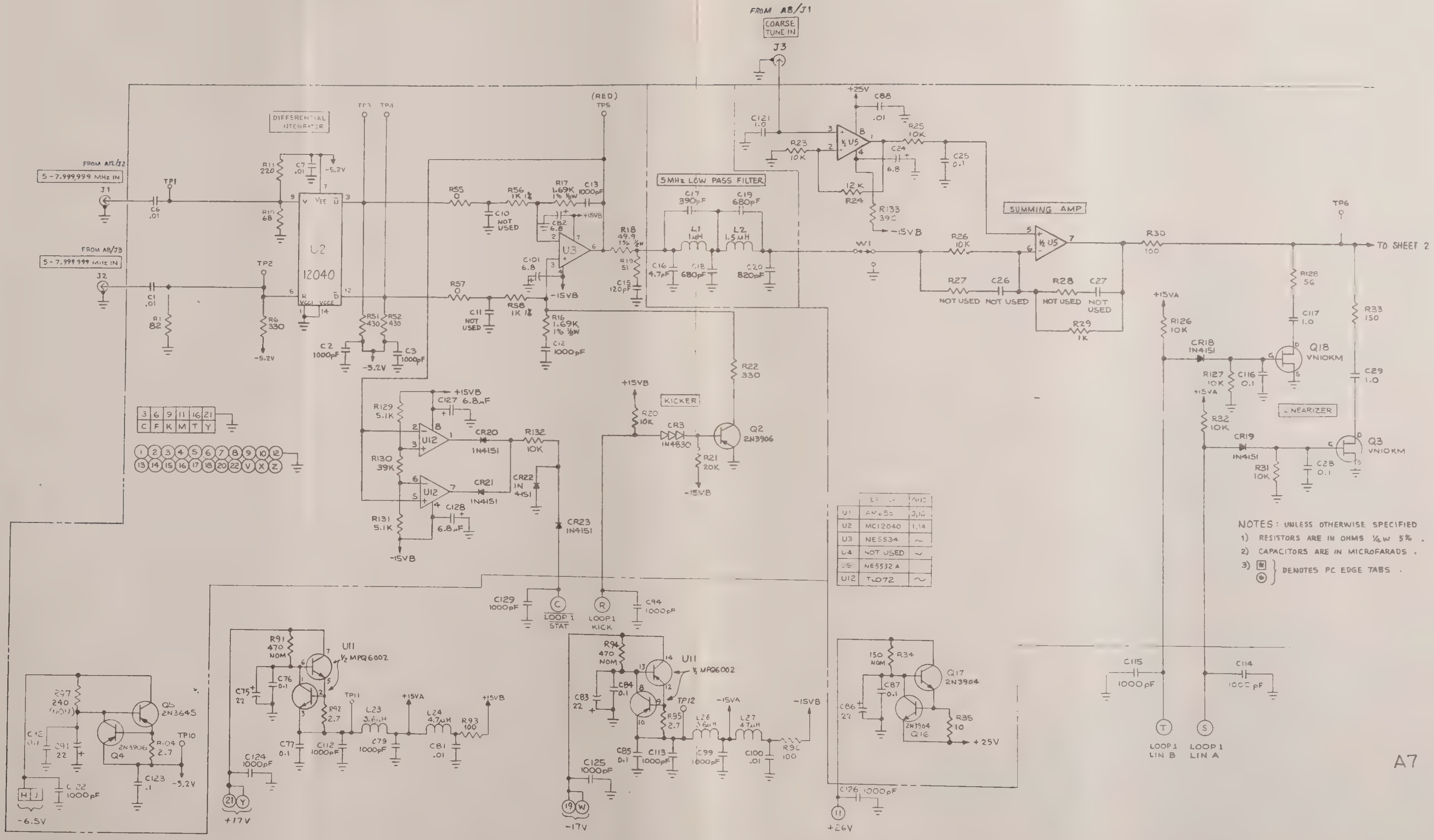
1) SURFACE MOUNT COMPONENTS
   NEARSIDE: C47, C50, Q6, Q7, Q8.
   FARSIDE: C60, U7, U8, U9, U13.

2) GND PLANES FOR SHIELDS MUST BE FREE OF SOLDER.

3) MARK "01" & REVISION LEVEL OF PC ASSY DWG WITH PERMANENT INK.

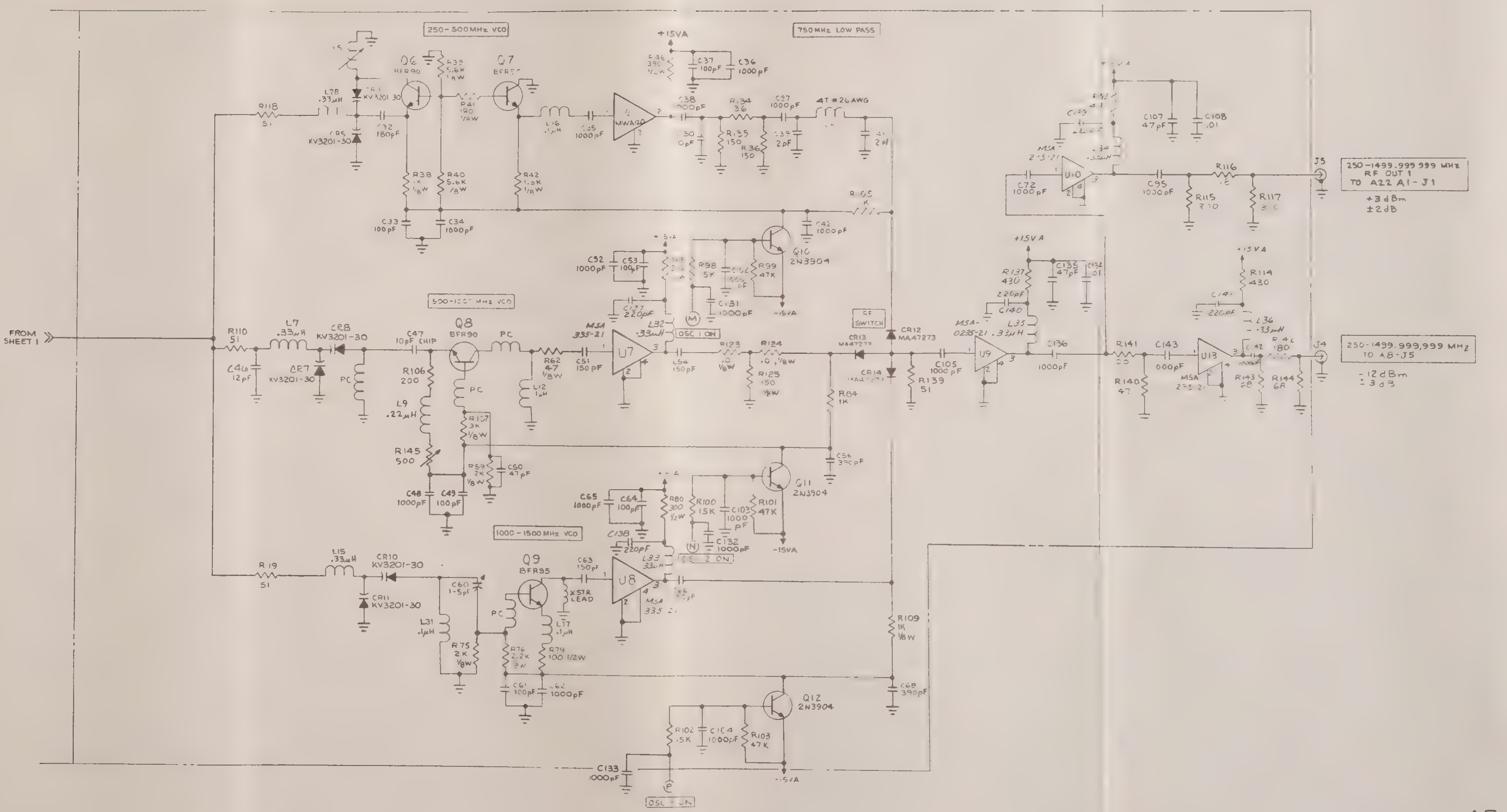
A7

Figure 5-27. Loop 1 Output PC Board Assembly A7


FROM A8/J1
COARSE TUNE IN
J3
FROM A12/J2
5 - 7.999,999 MHz IN
J1
TP1
C6 .01
FROM A8/J3
5 - 7.999,999 MHz IN
J2
C1 .01
R1 82
TP2
R6 330
-5.2V
DIFFERENTIAL INTEGRATOR
R11 220
R10 68
C7 .01
-5.2V
U2 12040
TP3
TP4
R51 430
R52 430
C2 1000pF
C3 1000pF
-5.2V
(RED) TP5
R55 0
C10 NOT USED
R56 1K 1%
R17 1.69K 1% 1/8W
C13 1000pF
C82 6.8
+15VB
U3
C101 6.8
-15VB
R57 0
C11 NOT USED
R58 1K 1%
R16 1.69K 1% 1/8W
C12 1000pF
R18 49.9 1% 1/8W
R19 51
C15 120pF
5MHz LOW PASS FILTER
C17 390pF
C19 680pF
L1 1μH
L2 1.5μH
C16 4.7pF
C18 680pF
C20 820pF
W1
C121 1.0
+25V
C88 .01
R23 10K
1/2 U5
R25 10K
C24 6.8
C25 0.1
12K R24
R133 39C
-15VB
SUMMING AMP
R26 10K
1/2 U5
R27 NOT USED
C26 NOT USED
R28 NOT USED
C27 NOT USED
R29 1K
R30 100
TP6
TO SHEET 2
R128 56
C117 1.0
R33 150
+15VA
R126 10K
CR18 1N4151
Q18 VN10KM
R127 10K
C116 0.1
C29 1.0
+15VA
R32 10K
LINEARIZER
CR19 1N4151
Q3 VN10KM
R31 10K
C28 0.1
R22 330
+15VB
KICKER
R20 10K
CR3 1N4830
R21 20K
-15VB
Q2 2N3906
+15VB
R129 5.1K
C127 6.8μF
U12
CR20 1N4151
R132 10K
R130 39K
U12
CR21 1N4151
CR22 IN 4151
R131 5.1K
C128 6.8μF
-15VB
CR23 1N4151
3 6 9 11 16 21
C F K M T Y
1 2 3 4 5 6 7 8 9 10 12
13 14 15 16 17 18 20 22 V X Z
C129 1000pF
C LOOP 1 STAT
R LOOP 1 KICK
C94 1000pF
R91 470 NOM
U11 1/2 MPQ6002
C75 22
C76 0.1
TP11
R92 2.7
L23 3.6μH
+15VA
L24 4.7μH
R93 100
+15VB
C77 0.1
C112 1000pF
C79 1000pF
C81 .01
C124 1000pF
21 Y
+17V
R94 470 NOM
U11 1/2 MPQ6002
C83 22
C84 0.1
TP12
R95 2.7
L26 3.6μH
-15VA
L27 4.7μH
R96 100
-15VB
C85 0.1
C113 1000pF
C99 1000pF
C100 .01
C125 1000pF
19 W
-17V
R97 240
Q5 2N3645
C42 0.1
C91 22
Q4 2N3906
R104 2.7
TP10
C122 1000pF
C123 .1
-5.2V
H J
-6.5V
150 NOM R34
Q17 2N3904
C87 0.1
C86 22
Q16 2N3904
R35 10
+25V
C126 1000pF
11
+26V
C115 1000pF
C114 1000pF
T LOOP 1 LIN B
S LOOP 1 LIN A
U1 AM685 3,10
U2 MC12040 1,14
U3 NE5534
U4 NOT USED
U5 NE5532A
U12 TL072
A7

NOTES: UNLESS OTHERWISE SPECIFIED
1) RESISTORS ARE IN OHMS 1/4W 5%.
2) CAPACITORS ARE IN MICROFARADS.
3) ▣ ⊛ } DENOTES PC EDGE TABS.

Figure 5-28. Loop 1 A7 Schematic (Sheet 1 of 2)


250-500MHz VCO
750MHz LOW PASS
500-1000 MHz VCO
1000-1500 MHz VCO
FROM SHEET 1
Q6 BFR90
Q7
Q8 BFR90
Q9 BFR95
Q10 2N3904
Q11 2N3904
Q12 2N3904
MWA120
U7 MSA 335-21
U8 MSA 335-21
U9 MSA-0235-21
U10
U13
+15VA
-15VA
R110 51
L7 .33μH
CR8 KV3201-30
CR7 KV3201-30
C46 12pF
C47 10pF CHIP
R106 200
L9 .22μH
R145 500
C48 1000pF
C49 100pF
R59 2K 1/8W
C50 47pF
R62 47 1/8W
L12 .1μH
C51 150 pF
R118 51
L28 .33μH
CR5 KV3201-30
C32 180pF
R38 1K 1/8W
R40 5.6K 1/8W
R42 1.5K 1/8W
C33 100pF
C34 1000pF
L16 .1μH
C35 1000pF
C37 100pF
C36 1000pF
C38 1000pF
R134 36
R135 150
R136 150
C39 2pF
4T #26AWG
C52 1000pF
C53 100pF
R98 5K
R99 47K
C131 1000pF
C137 220pF
L32 .33μH
OSC 1 ON
C54 150pF
R124
R125 150 1/8W
RF SWITCH
CR12 MA47273
CR13 MA47273
CR14
R139 51
R84 1K
C56 390pF
C105 1000 pF
R137 430
C135 47pF
C140 220pF
L35 .33μH
C136 1000pF
R141
C143
R140 47
R114 430
L36 .33μH
R143 68
R144 68
C107 47pF
C108 .01
C72 1000pF
C95 1000pF
R116
R115
R117
J5
250-1499.999 999 MHz RF OUT 1 TO A22 A1-J1
+3 dBm ±2dB
J4
250-1499.999,999 MHz TO A8-J5
-12 dBm ±3 dB
C65 1000pF
C64 100pF
R80 300 1/2W
R100 1.5K
C103 1000 pF
R101 47K
C138 220pF
C132 1000pF
L33 .33μH
OSC 2 ON
R19 51
L15 .33μH
CR10 KV3201-30
CR11 KV3201-30
C60 1-5pF
L31 .1μH
R75 2K 1/8W
R76 2.2K
R79 100 1/2W
L17 .1μH
C63 150pF
XSTR LEAD
C61 100pF
C62 1000pF
R109 1K 1/8W
C68 390pF
R102 1.5K
C104 1000pF
R103 47K
C133 1000pF
OSC 3 ON
PC

A7

Figure 5-28. Loop 1 A7 Schematic (Sheet 2 of 2)

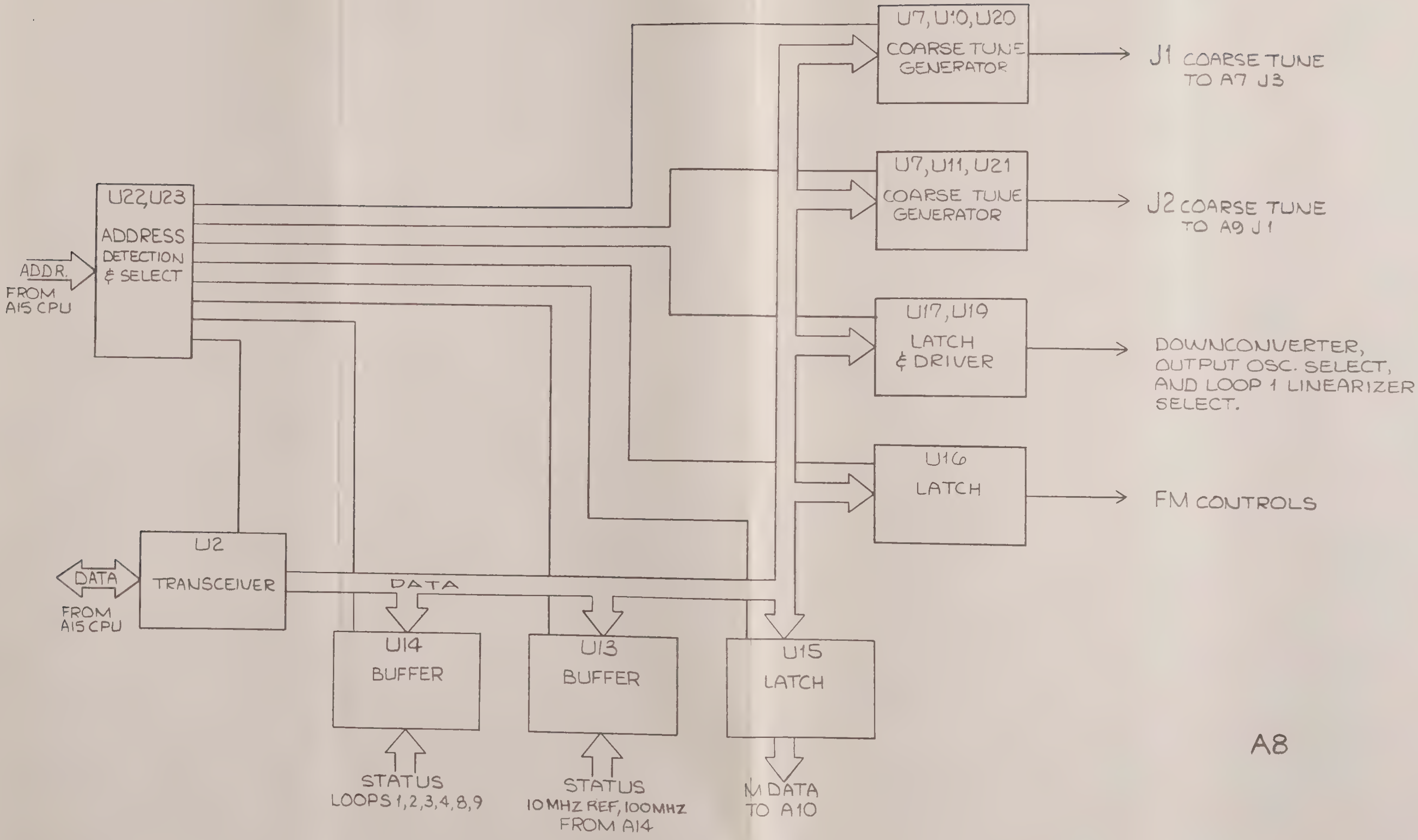

U7, U10, U20
COARSE TUNE GENERATOR
J1 COARSE TUNE TO A7 J3
U7, U11, U21
COARSE TUNE GENERATOR
J2 COARSE TUNE TO A9 J1
U22, U23
ADDRESS DETECTION & SELECT
ADDR.
FROM A15 CPU
U17, U19
LATCH & DRIVER
DOWNCONVERTER, OUTPUT OSC. SELECT, AND LOOP 1 LINEARIZER SELECT.
U16
LATCH
FM CONTROLS
U2
TRANSCEIVER
DATA
FROM A15 CPU
DATA
U14
BUFFER
STATUS LOOPS 1,2,3,4,8,9
U13
BUFFER
STATUS 10 MHZ REF, 100MHZ FROM A14
U15
LATCH
N DATA TO A10
A8

Figure 5-29. Loop 1 IF A8 Block Diagram (Sheet 1 of 2)

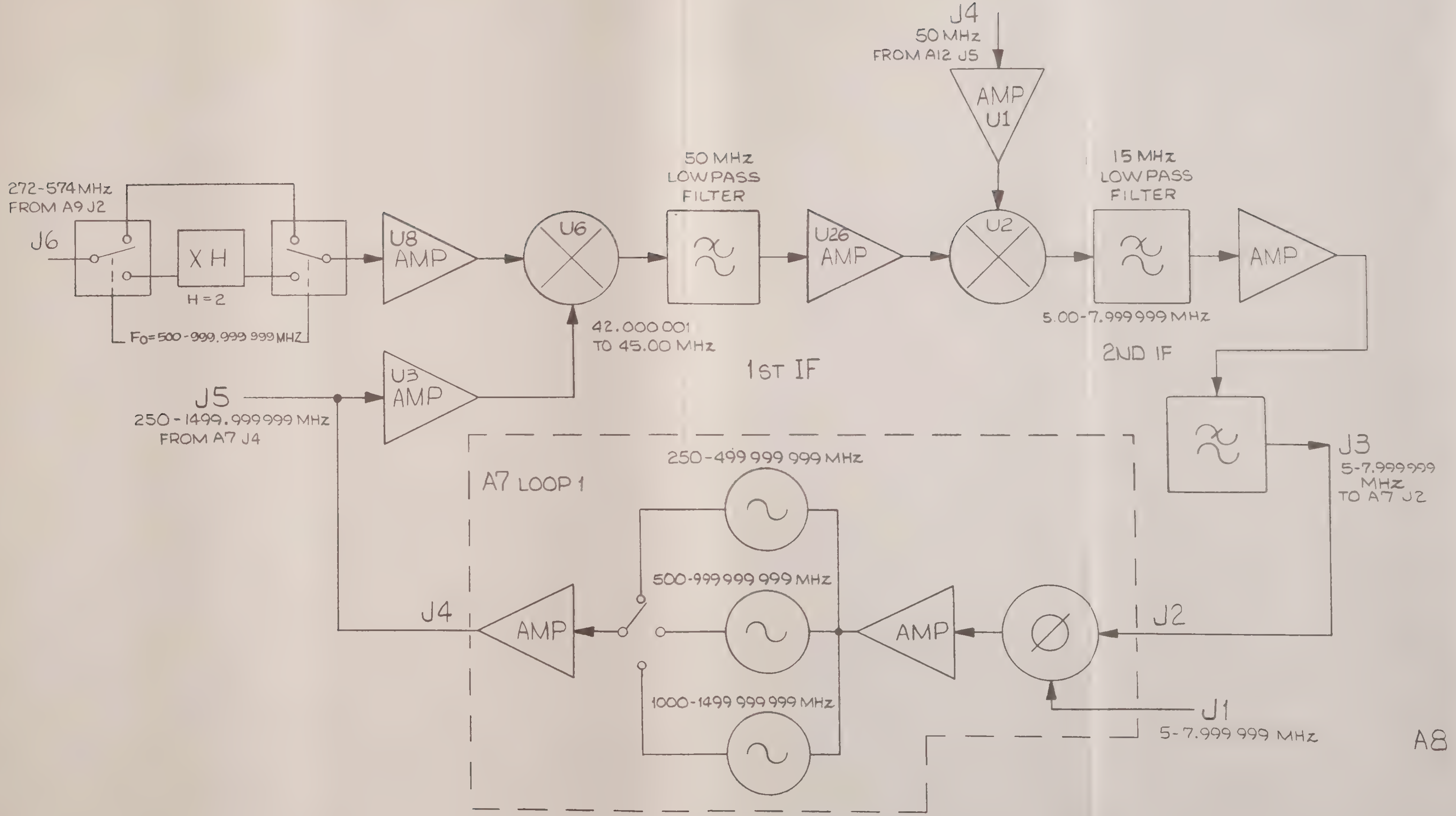
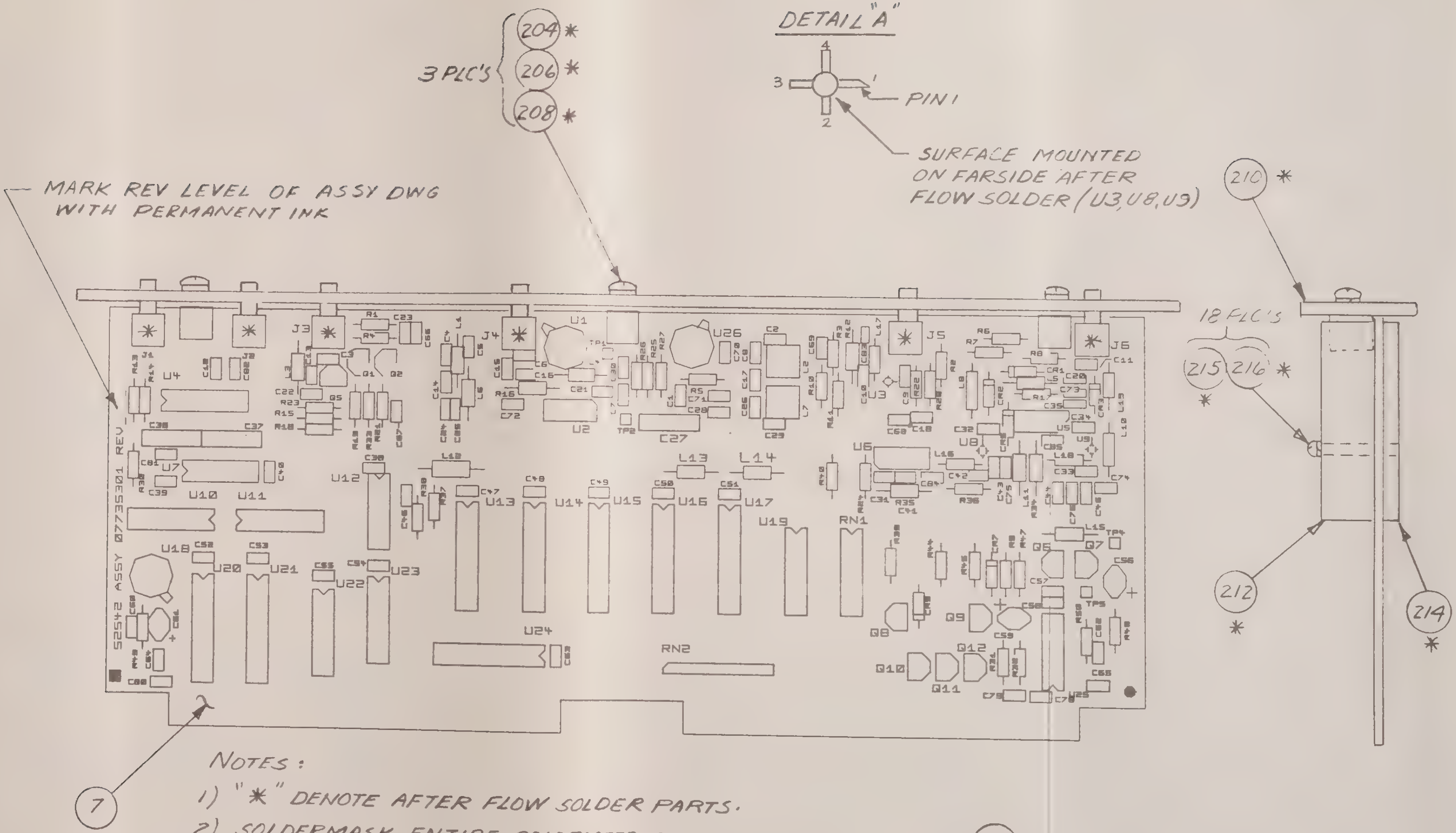

J4
50 MHz
FROM A12 J5
AMP
U1
272-574 MHz
FROM A9 J2
J6
XH
H=2
F0=500-999.999 999 MHZ
U8
AMP
U6
50 MHz
LOW PASS
FILTER
U26
AMP
U2
15 MHz
LOW PASS
FILTER
AMP
42.000 001
TO 45.00 MHz
1ST IF
5.00-7.999 999 MHz
2ND IF
J5
250-1499.999 999 MHz
FROM A7 J4
U3
AMP
J3
5-7.999 999
MHz
TO A7 J2
A7 LOOP 1
250-499 999 999 MHz
500-999 999 999 MHz
1000-1499 999 999 MHz
J4
AMP
AMP
J2
J1
5-7.999 999 MHz
A8

Figure 5-29. Loop 1 IF A8 Block Diagram (Sheet 2 of 2)


3 PLC'S
204 *
206 *
208 *
DETAIL "A"
4
3
1
2
PIN 1
SURFACE MOUNTED ON FARSIDE AFTER FLOW SOLDER (U3,U8,U9)
MARK REV LEVEL OF ASSY DWG WITH PERMANENT INK
210 *
18 PLC'S
215 *
216 *
212 *
214 *
7
52542 ASSY 07735301 REV
J1
J2
J3
J4
J5
J6
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
U14
U15
U16
U17
U18
U19
U20
U21
U22
U23
U24
U25
U26
RN1
RN2
Q1
Q2
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
L12
L13
L14
L15
L16
C27
TP1
TP2
TP4
TP5

NOTES:

1) "*" DENOTE AFTER FLOW SOLDER PARTS.

2) SOLDERMASK ENTIRE GOLDPLATED OUTLINE OF SHIELD, ITEM (214) ON SOLDER SIDE OF PCB BEFORE LOADING.

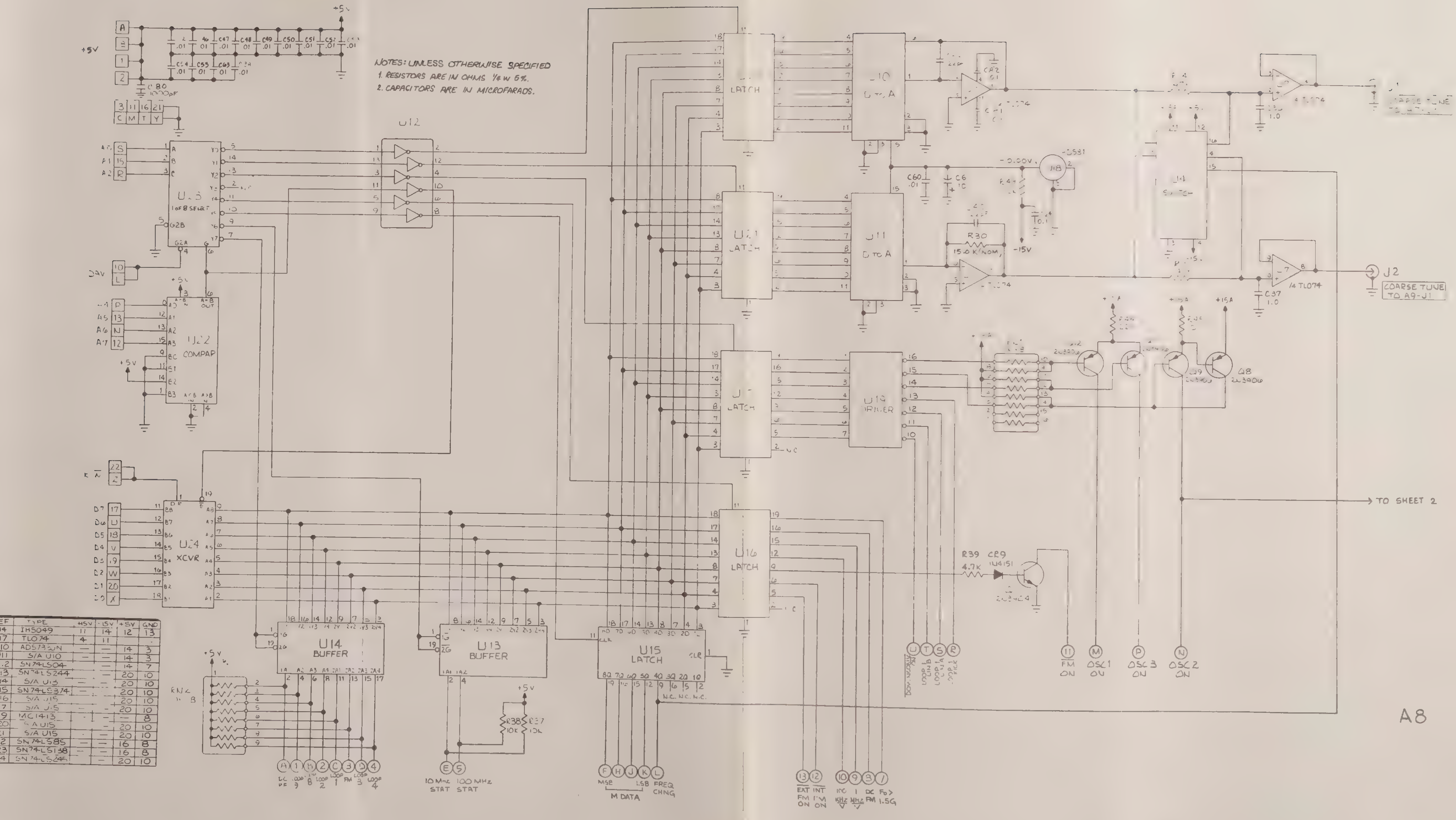
3) USE GLASS BEADS ONLY ON CAPS WHOSE LEADS ARE BENT.

4) SEE DETAIL "A" TO MOUNT U3, U8 & U9.

(REF: P.C.B. REV E)

A8

Figure 5-30. Loop 1 IF PC Board Assembly A8


+5V
C80 1000pF
C47 C48 C49 C50 C51 C52 .01
C54 C55 C63 .01
U12
U23 1 OF 8 SELECT
G2B G2A
DAV
U22 COMPAR
A=B IN A=B OUT
A>B A<B
U24 XCVR
D7 D6 D5 D4 D3 D2 D1 D0
U14 BUFFER
U13 BUFFER
U15 LATCH
U16 LATCH
U17 LATCH
U21 LATCH
LATCH
U10 D TO A
U11 D TO A
U19 DRIVER
U14 SWITCH
U18 -2.00V 1N5531
R30 15.0 K NOM
C60 .01
C6 10
C37 1.0
1/4 TL074
-15V
+15V
RN2
R38 10K
R37 10K
R39 4.7K
CR9 1N4151
2N3904
Q8 2N3906
Q9 2N3906
J2
COARSE TUNE TO A9-J1
FINE TUNE TO A9-J1
TO SHEET 2
10 MHz STAT
100 MHz STAT
MSB LSB M DATA
FREQ CHNG
EXT FM ON
INT FM ON
INC KHZ
1 MHz
DC FM
Fo > 1.5G
FM ON
OSC1 ON
OSC3 ON
OSC2 ON
LOOP 1
LOOP 2
LOOP 3
LOOP 4
FM
N.C.
A8

NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS 1/4 W 5%.
2. CAPACITORS ARE IN MICROFARADS.

EF	TYPE	+15V	-15V	+5V	GND
4	IH5049	11	14	12	13
7	TL074	4	11		
10	ADS73JN	—	—	14	3
11	S/A U10	—	—	14	3
.2	SN74LS04		—	14	7
13	SN74LS244		—	20	10
14	S/A U13	—	—	20	10
15	SN74LS374	—		20	10
16	S/A U15			20	10
7	S/A U15	—	—	20	10
9	MC1413		—	—	8
20	S/A U15		—	20	10
1	S/A U15		—	20	10
2	SN74LS85	—	—	16	8
3	SN74LS138	—	—	16	8
4	SN74LS245		—	20	10

Figure 5-31. Loop 1 IF A8 Schematic (Sheet 1 of 2)

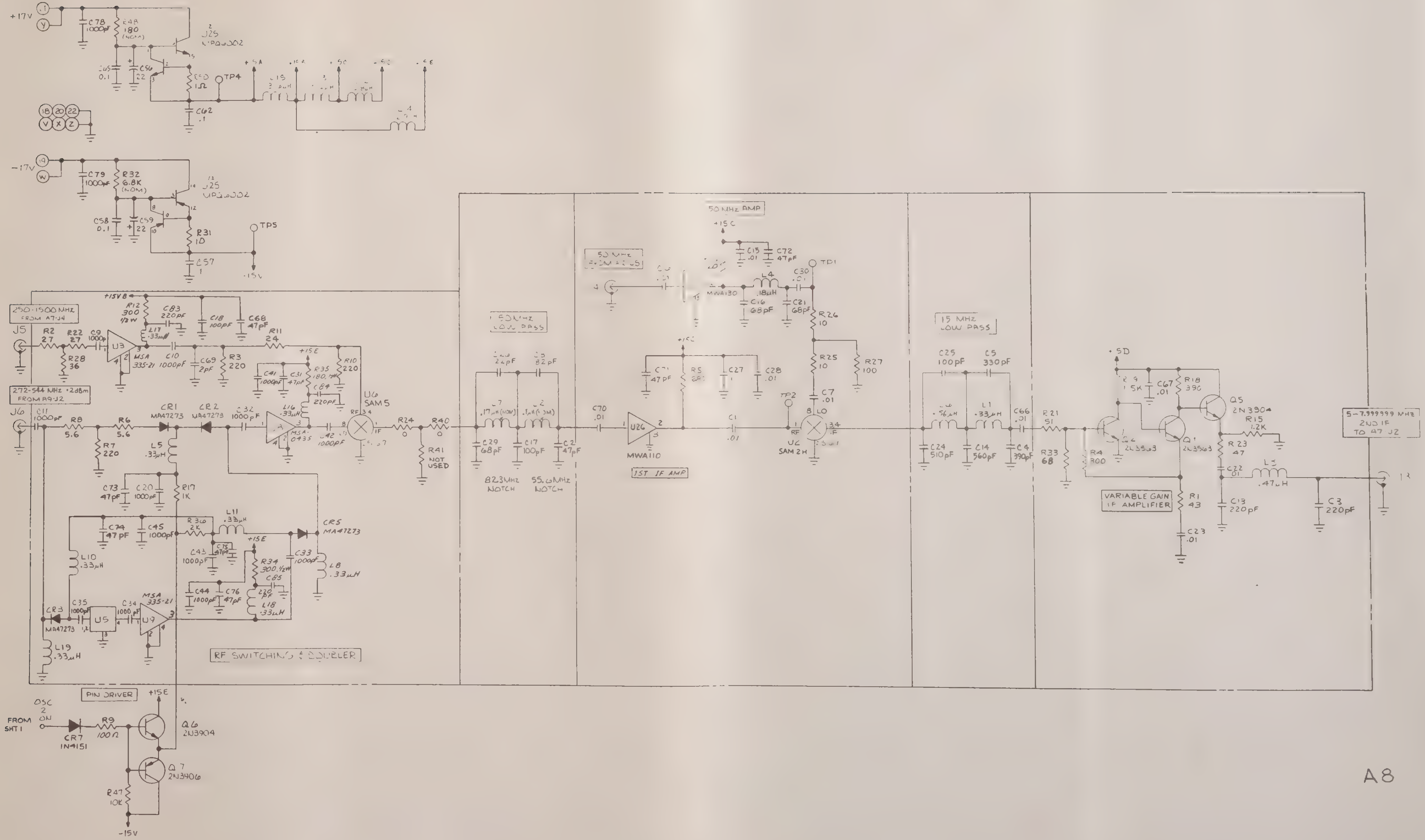
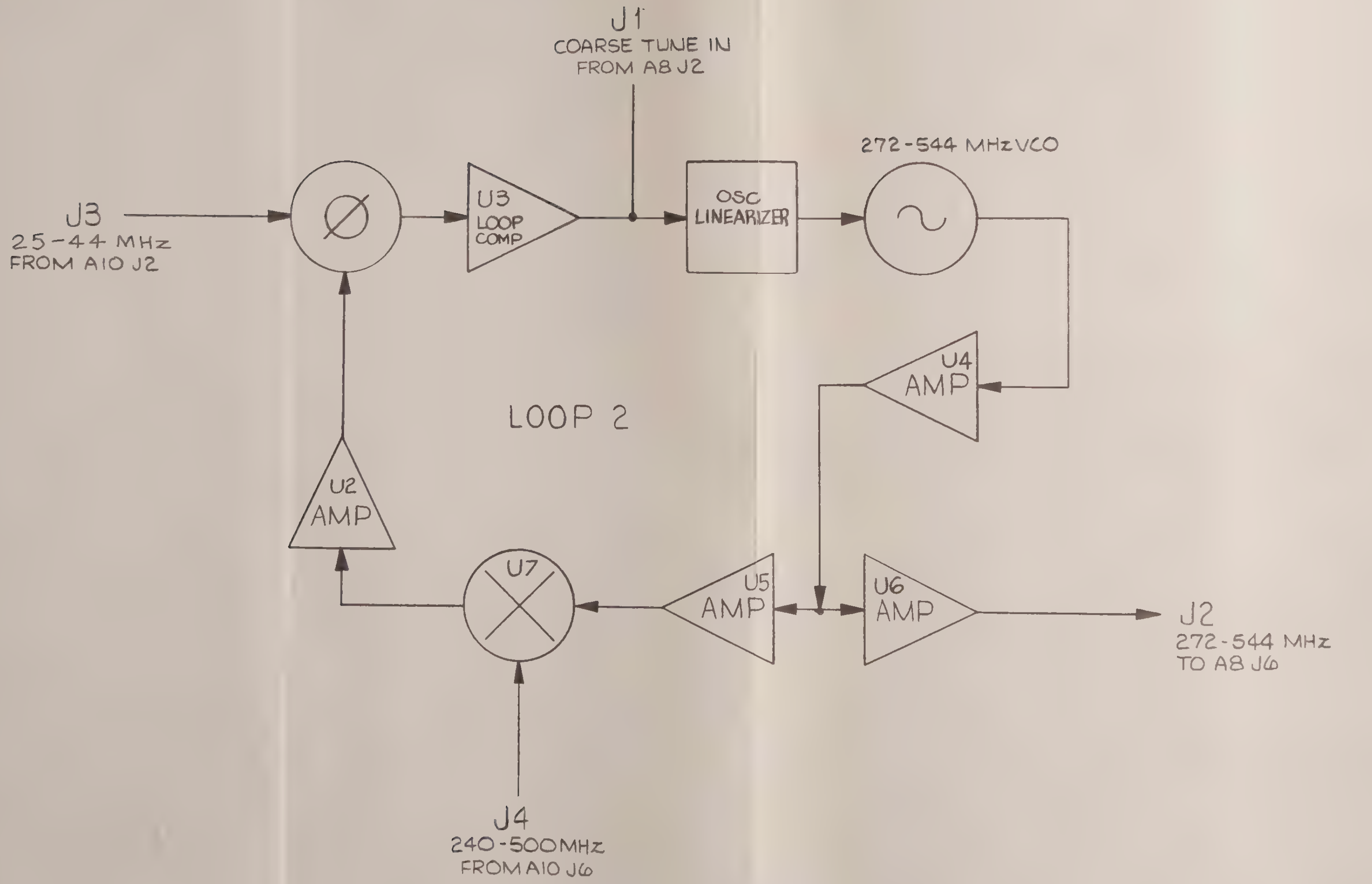
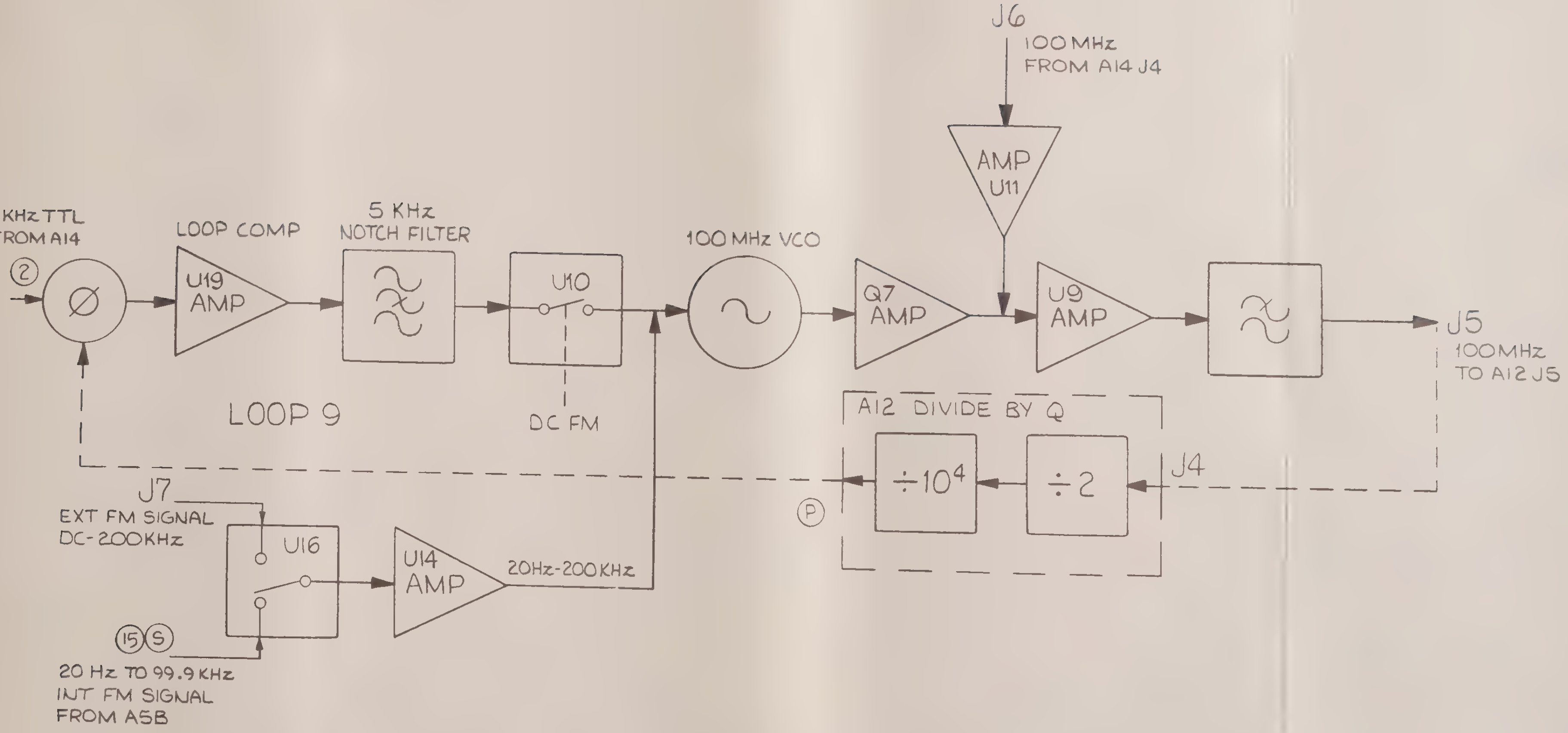

+17V
C78 1000pF
R48 180 (NOM)
U25 UPQ6002
C55 0.1
C56 22
R50 1Ω
TP4
C62 .1
+5A
+5B
+5C
+5D
+5E
L15
18 20 22
V X Z
-17V
C79 1000pF
R32 6.8K (NOM)
U25 UPQ6002
C58 0.1
C59 22
R31 10
TP5
C57 1
-15V
+15VB
R12 300 1/2W
C83 220pF
C18 100pF
C68 47pF
L17 .33μH
250-1500 MHz FROM A7-J4
J5
R2 27
R22 27
C9 1000p
U3
MSA 335-21
R28 36
C10 1000pF
C69 2pF
R3 220
R11 24
+15E
C41 1000pF
C31 47pF
R35 180
R10 220
C84 220pF
L16 .33μH
272-544 MHz +2dBm FROM A9-J2
J6
C11 1000pF
R8 5.6
R6 5.6
R7 220
CR1 MA47273
CR2 MA47273
C32 1000pF
MSA-0435
C42 1000pF
U6 SAM5
RF
IF
R24 0
R40 0
R41 NOT USED
L5 .33μH
C73 47pF
C20 1000pF
R17 1K
L11 .33μH
R36 2K
C74 47pF
C45 1000pF
C43 1000pF
C75 47pF
+15E
R34 300 1/2W
C85 220pF
L18 .33μH
C33 1000pF
CR5 MA47273
L8 .33μH
L10 .33μH
C44 1000pF
C76 47pF
CR3 MA47273
C35 1000pF
U5
C34 1000pF
U9
MSA 335-21
L19 .33μH
RF SWITCHING & DOUBLER
PIN DRIVER
OSC 2 ON FROM SHT 1
CR7 1N4151
R9 100Ω
+15E
Q6 2N3904
Q7 2N3906
R47 10K
-15V
50MHz LOW PASS
C29 68pF
C17 100pF
C2 47pF
L7 .17μH (NOM)
L2 .1μH (NOM)
82.3MHz NOTCH
55.6MHz NOTCH
C70 .01
U26 MWA110
1ST IF AMP
50 MHz AMP
+15C
C15 .01
C72 47pF
50 MHz FROM A2 J51
MWA130
L4 .18μH
C16 68pF
C21 68pF
C30 .01
TP1
R26 10
R25 10
R27 100
C7 .01
C71 47pF
R5
C27
C28 .01
C1 .01
TP2
U2 SAM 2H
LO
RF
IF
15 MHz LOW PASS
C25 100pF
C5 330pF
L6 .56μH
L1 .33μH
C66 .01
C24 510pF
C14 560pF
C4 390pF
R21 51
R33 68
+5D
R19 1.5K
C67 .01
R18 390
Q5 2N3904
Q2 2N3563
Q1 2N3563
R4 300
R15 1.2K
R23 47
C22 .01
L3 .47μH
VARIABLE GAIN IF AMPLIFIER
R1 43
C23 .01
C13 220pF
C3 220pF
5-7.999999 MHz 2ND IF TO A7 J2
J2
A8

Figure 5-31. Loop 1 IF A8 Schematic (Sheet 2 of 2)


J1
COARSE TUNE IN
FROM A8 J2
272-544 MHz VCO
J3
25-44 MHz
FROM A10 J2
∅
U3
LOOP
COMP
OSC
LINEARIZER
U4
AMP
LOOP 2
U2
AMP
U7
U5
AMP
U6
AMP
J2
272-544 MHz
TO A8 J6
J4
240-500 MHz
FROM A10 J6

A9

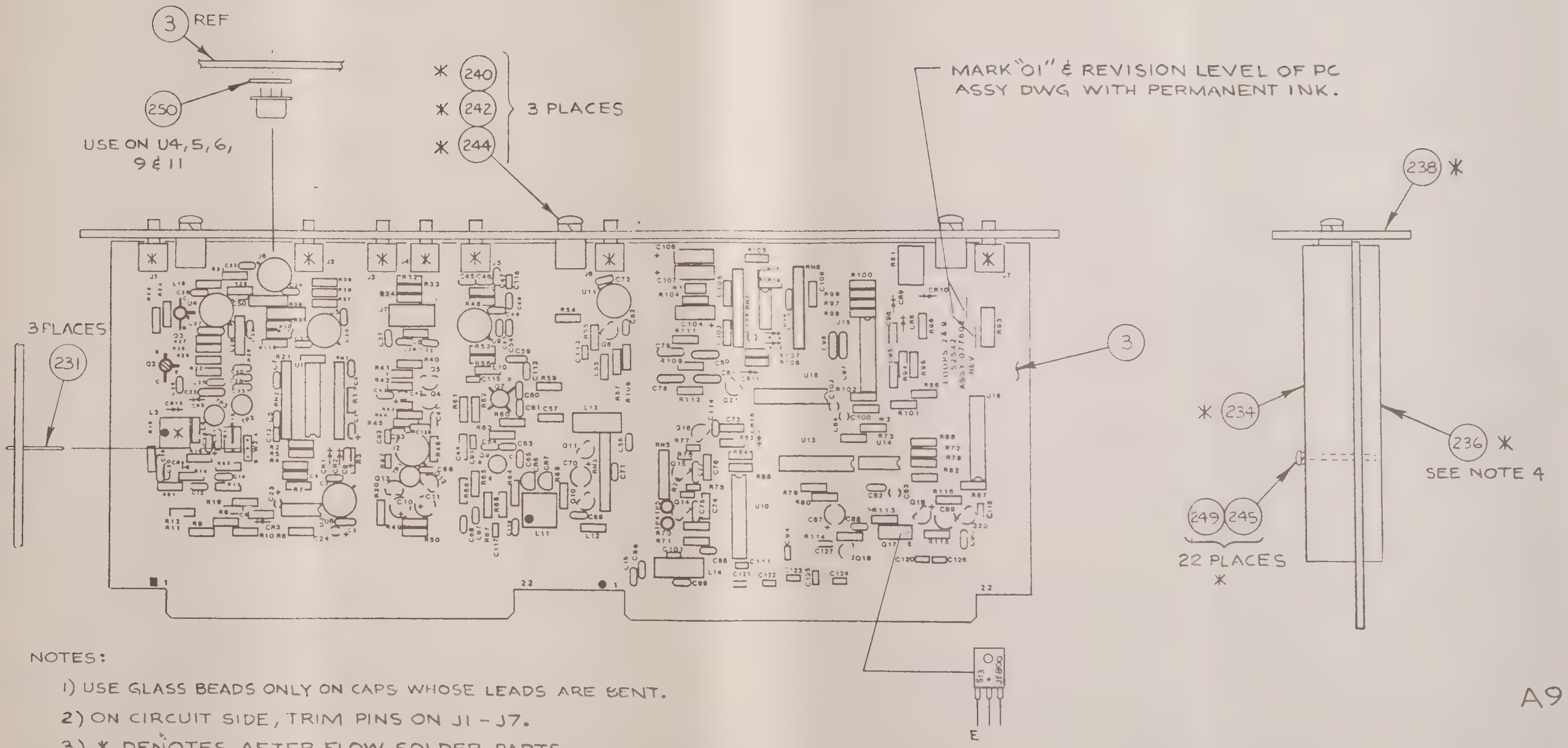
Figure 5-32. Loops 2 and 9 A9 Block Diagram (Sheet 1 of 2)



J6
100 MHz
FROM A14 J4
AMP
U11
5KHz TTL
FROM A14
②
LOOP COMP
U19
AMP
5 KHz
NOTCH FILTER
U10
100 MHz VCO
Q7
AMP
U9
AMP
J5
100 MHz
TO A12 J5
LOOP 9
DC FM
A12 DIVIDE BY Q
÷10⁴
÷2
J4
Ⓟ
J7
EXT FM SIGNAL
DC-200KHz
U16
U14
AMP
20Hz-200KHz
⑮Ⓢ
20 Hz TO 99.9 KHz
INT FM SIGNAL
FROM A5B

A9

Figure 5-32. Loops 2 and 9 A9 Block Diagram (Sheet 2 of 2)


③ REF
250
USE ON U4, 5, 6, 9 & 11
✱ 240
✱ 242
✱ 244
3 PLACES
MARK "01" & REVISION LEVEL OF PC ASSY DWG WITH PERMANENT INK.
238 ✱
3 PLACES
231
3
✱ 234
236 ✱
SEE NOTE 4
249 245
22 PLACES
✱
J1
J2
J3
J6
E
A9

NOTES:

1) USE GLASS BEADS ONLY ON CAPS WHOSE LEADS ARE BENT.

2) ON CIRCUIT SIDE, TRIM PINS ON J1 - J7.

3) ✱ DENOTES AFTER FLOW SOLDER PARTS.

4) SOLDERMASK ENTIRE GOLD-PLATED OUTLINE OF SHIELD ON SOLDER SIDE OF PC BOARD BEFORE LOADING.

Figure 5-33. Loops 2 and 9 PC Board Assembly A9

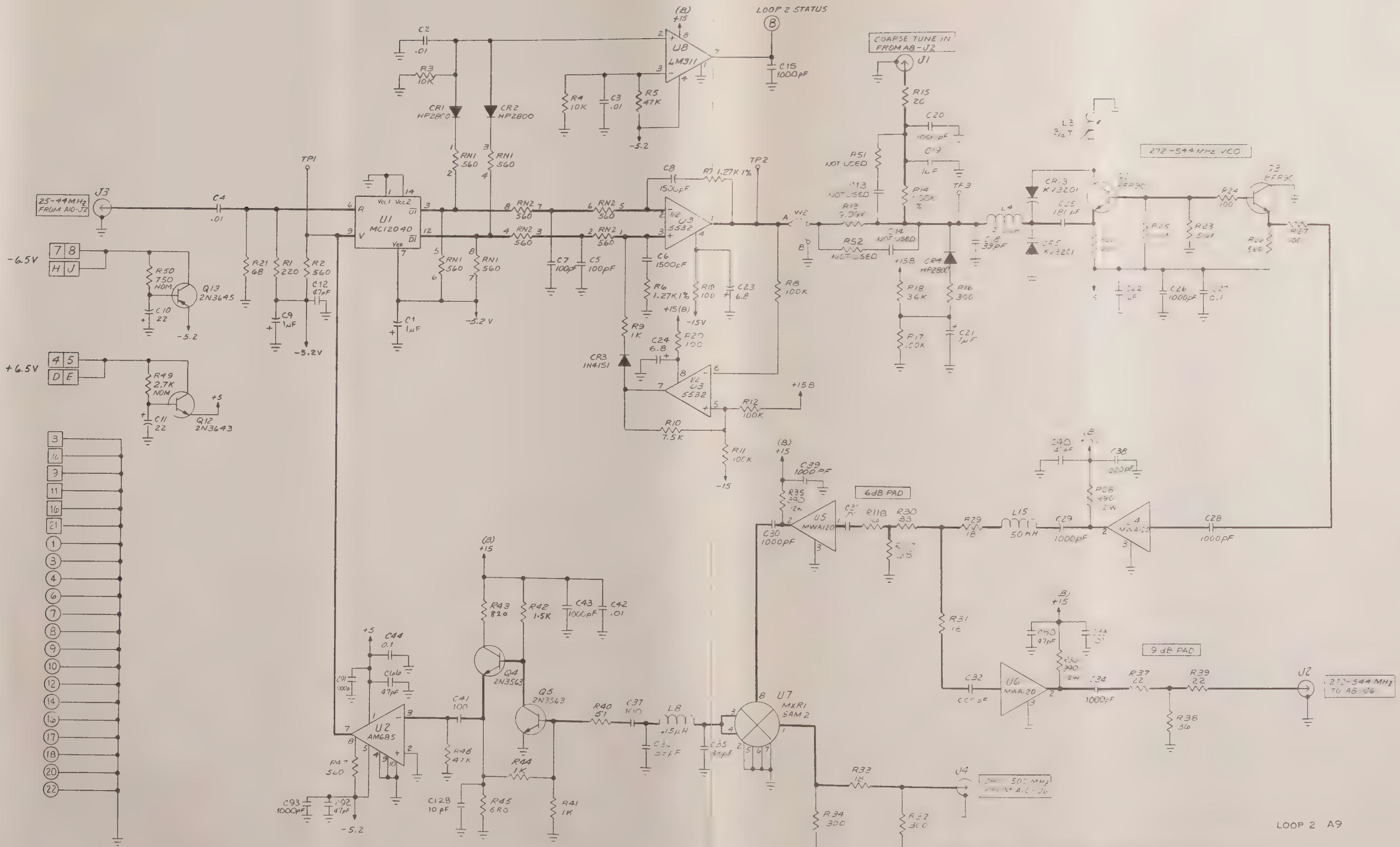
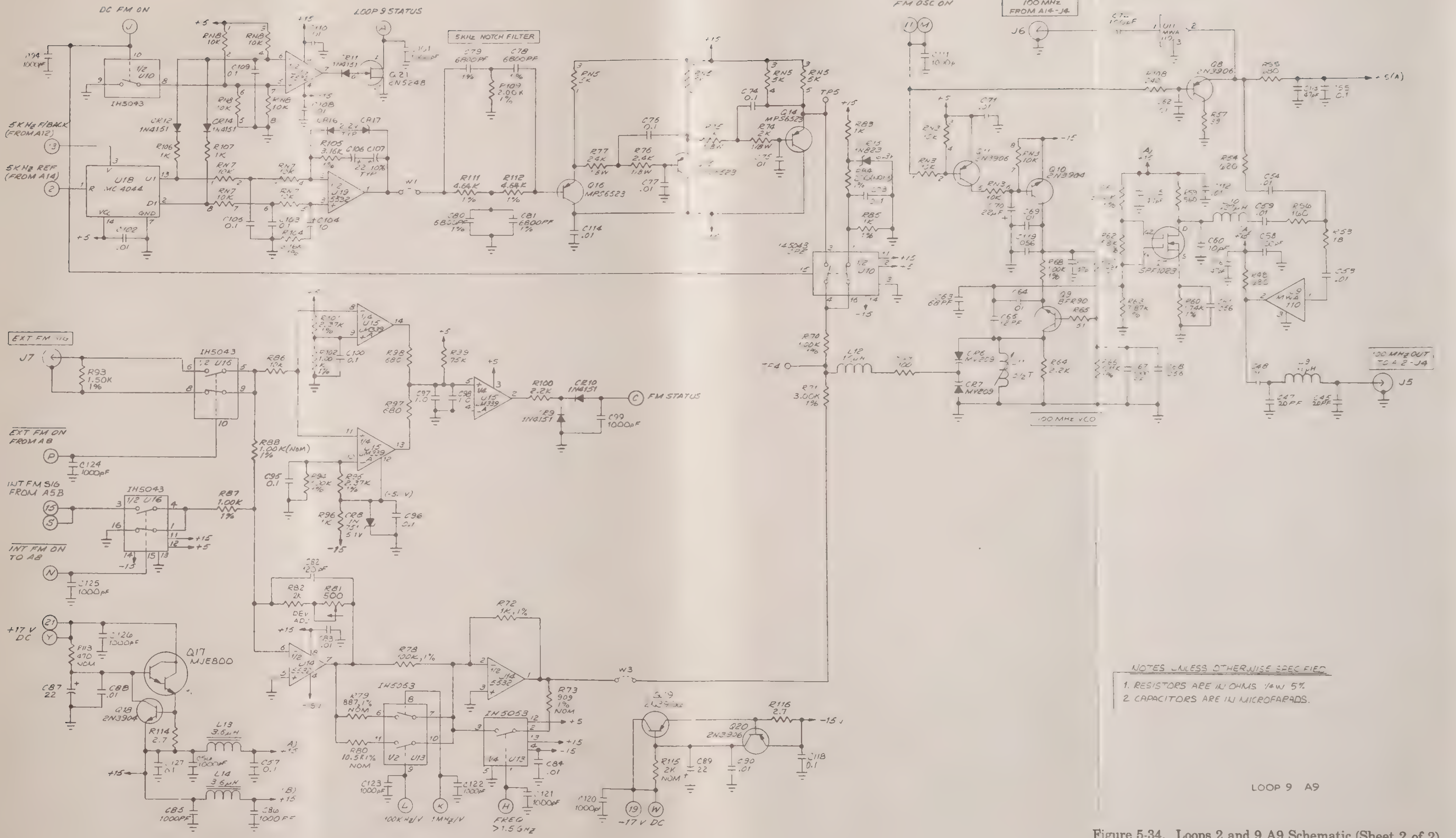

LOOP 2 STATUS
(B) +15
U8 LM311
C15 1000pF
C2 .01
R3 10K
CR1 HP2800
CR2 HP2800
R4 10K
C3 .01
R5 47K
-5.2
COARSE TUNE IN FROM A8-J2
J1
R15 20
C20 1000pF
C19 1uF
R51 NOT USED
C13 NOT USED
R13 9.09K
R14 100K
C14 NOT USED
R52 NOT USED
TP3
L3 3/4 T
272-544 MHz VCO
CR13 KV3201
CR5 KV3201
C25 181pF
L4
C18 39pF
Q1 BFR90
Q3 BFR90
R24 100
R25
R23
R26 560
R27 100
C22 1uF
C26 1000pF
C27 0.1
TP1
TP2
J3
25-44MHz FROM A10-J2
C4 .01
U1 MC12040
RN1 560
RN2 560
C8 1500pF
R7 1.27K 1%
U3 5532
W2
C6 1500pF
C7 100pF
C5 100pF
R6 1.27K 1%
R19 100
C23 6.8
R8 100K
+15B
CR4 HP2800
R18 36K
R16 300
R17 100K
C21 1uF
-6.5V
7 8
H J
R50 750 NOM
Q13 2N3645
C10 22
-5.2
R21 68
R1 220
R2 560
C12 47pF
C9 1uF
-5.2V
C1 1uF
-5.2 V
+15(B)
-15V
R9 1K
C24 6.8
R20 100
CR3 1N4151
R12 100K
R10 7.5K
R11 100K
-15
+6.5V
4 5
D E
R49 2.7K NOM
Q12 2N3643
C11 22
+5
C40
C38
R28 390 2W
6dB PAD
C39 1000pF
R35 390
U5 MWA120
C30 1000pF
R118
R30 33
R29 18
L15 50nH
C29 1000pF
C28 1000pF
R31 18
9 dB PAD
U6 MWA120
C32
R36 390 2W
C34 1000pF
R37 22
R39 22
R38 36
J2
272-544 MHz TO A8-J6
R43 820
R42 1.5K
C43 1000pF
C42 .01
C44 0.1
C66 47pF
C91
U2 AM685
Q4 2N3563
Q5 2N3563
C41 100
R46 47K
R47 560
R44 1K
R40 51
C37 1000
L8 .15uH
C36
C35
U7 MXR1 SAM 2
R33 18
J4
C93 1000pF
C92 47pF
C128 10pF
R45 680
R41 1K
R34 300
R32 300
3
16
9
11
16
21
1
3
4
6
7
8
9
10
12
14
16
17
18
20
22
LOOP 2 A9

Figure 5-34. Loops 2 and 9 A9 Schematic (Sheet 1 of 2)


DC FM ON
LOOP 9 STATUS
5KHz NOTCH FILTER
FM OSC ON
100 MHz FROM A14-J4
J6
5KHz F/BACK (FROM A12)
5KHz REF (FROM A14)
U18 MC4044
1/2 U10 IH5043
U19 5532
Q21 2N5248
Q16 MPS6523
Q14 MPS6523
TP5
TP4
Q8 2N3906
Q11 2N3906
Q10 2N3904
Q9 BFR90
SPF1023
U9 MWA 110
U11 MWA 110
S(A)
100 MHz OUT TO A2-J4
J5
100 MHz VCO
EXT FM SIG
J7
IH5043 1/2 U16
EXT FM ON FROM A8
INT FM SIG FROM A5B
INT FM ON TO A8
1/4 U15 LM339
FM STATUS
+17 V DC
Q17 MJE800
Q18 2N3904
DEV ADJ
1/2 U14 5532
IH5053 U13
Q19
Q20 2N3906
100K Hz/V
1MHz/V
FREQ >1.5 GHz
-17 V DC
W1
W3

NOTES UNLESS OTHERWISE SPECIFIED

1. RESISTORS ARE IN OHMS 1/4W 5%.
2. CAPACITORS ARE IN MICROFARADS.

LOOP 9 A9

Figure 5-34. Loops 2 and 9 A9 Schematic (Sheet 2 of 2)

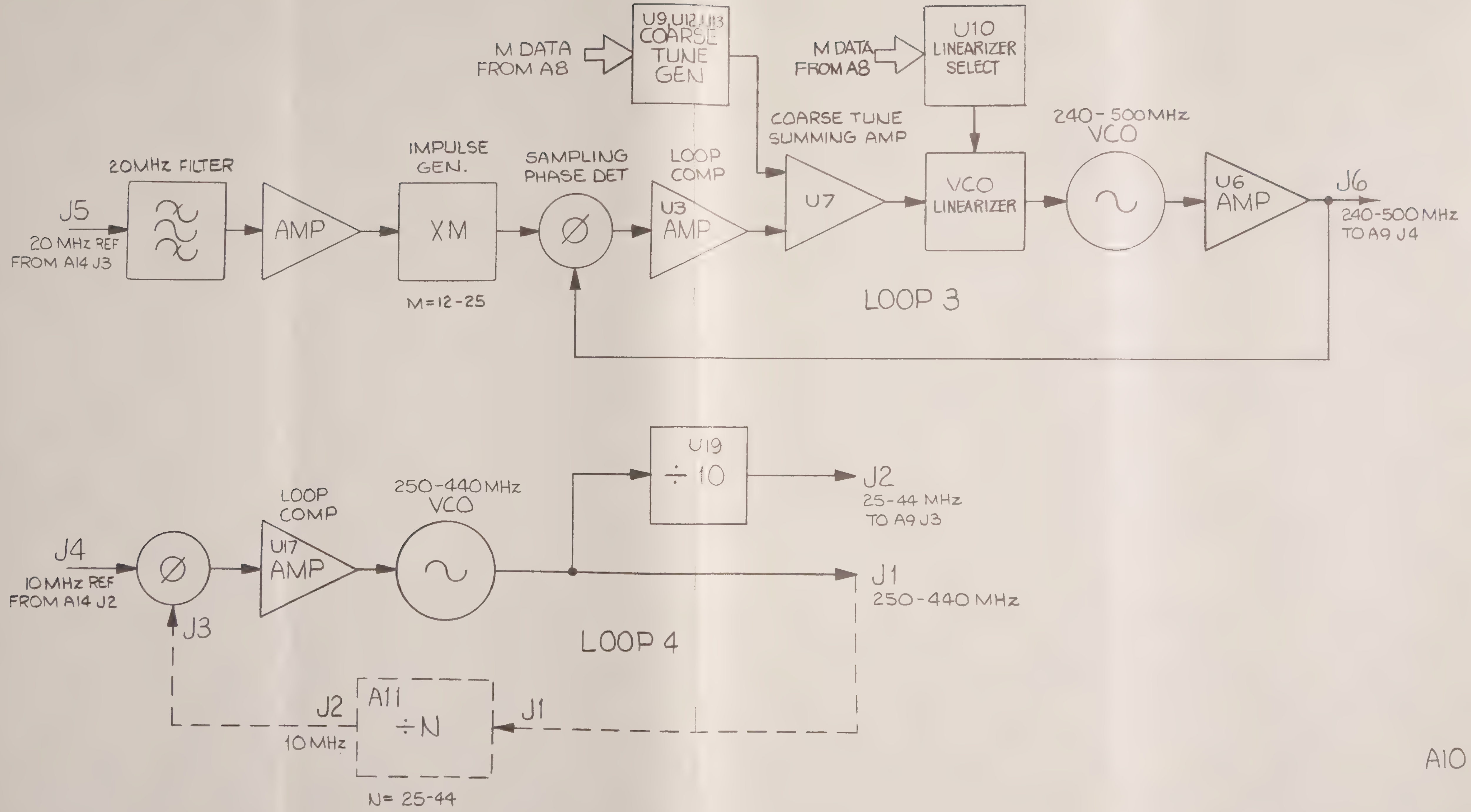
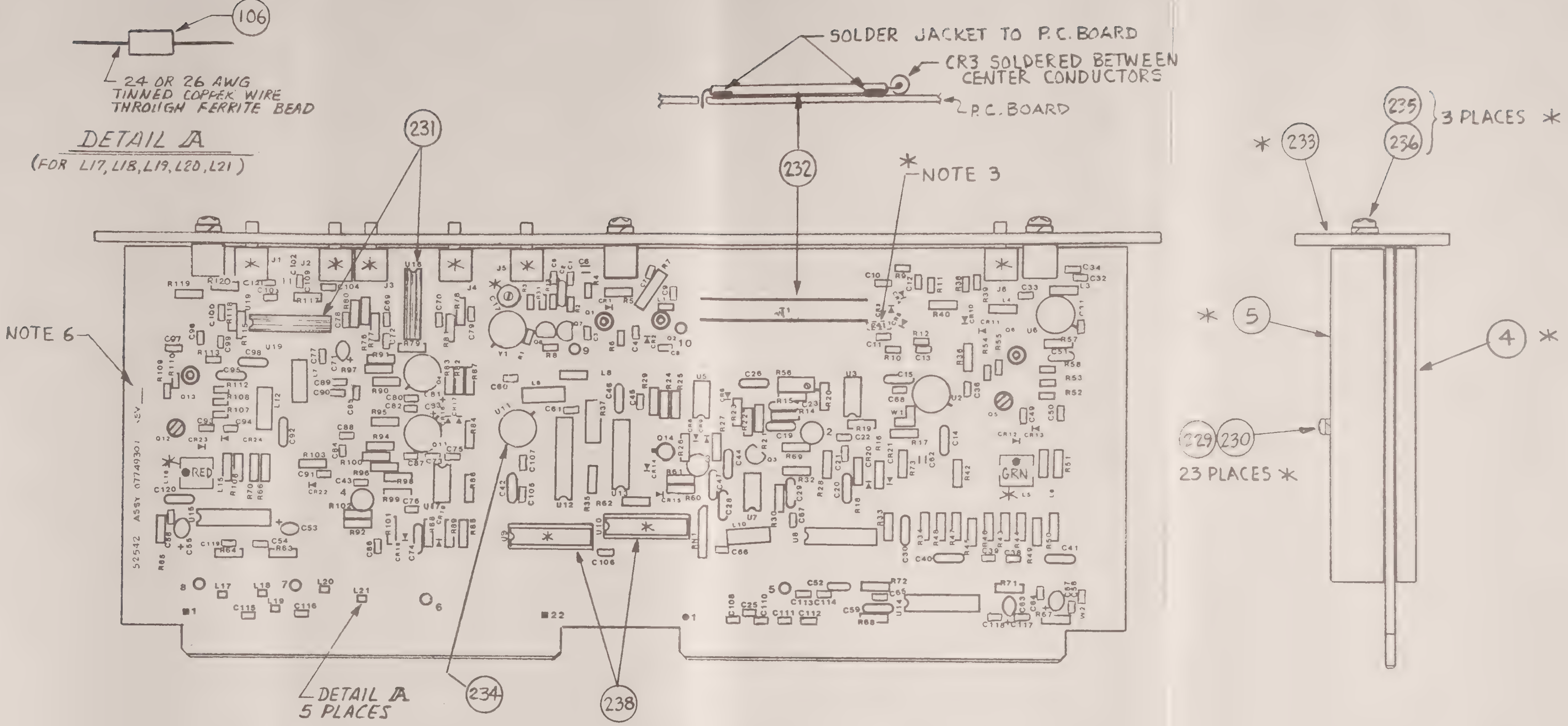

M DATA FROM A8
U9,U12,U13 COARSE TUNE GEN
M DATA FROM A8
U10 LINEARIZER SELECT
COARSE TUNE SUMMING AMP
240-500 MHz VCO
20MHz FILTER
IMPULSE GEN.
SAMPLING PHASE DET
LOOP COMP
J5
20 MHz REF FROM A14 J3
AMP
XM
M=12-25
Ø
U3 AMP
U7
VCO LINEARIZER
U6 AMP
J6
240-500 MHz TO A9 J4
LOOP 3
U19 ÷10
J2
25-44 MHz TO A9 J3
LOOP COMP
250-440 MHz VCO
J4
10 MHz REF FROM A14 J2
Ø
U17 AMP
J1
250-440 MHz
J3
LOOP 4
J2
A11 ÷N
J1
10 MHz
N= 25-44
A10

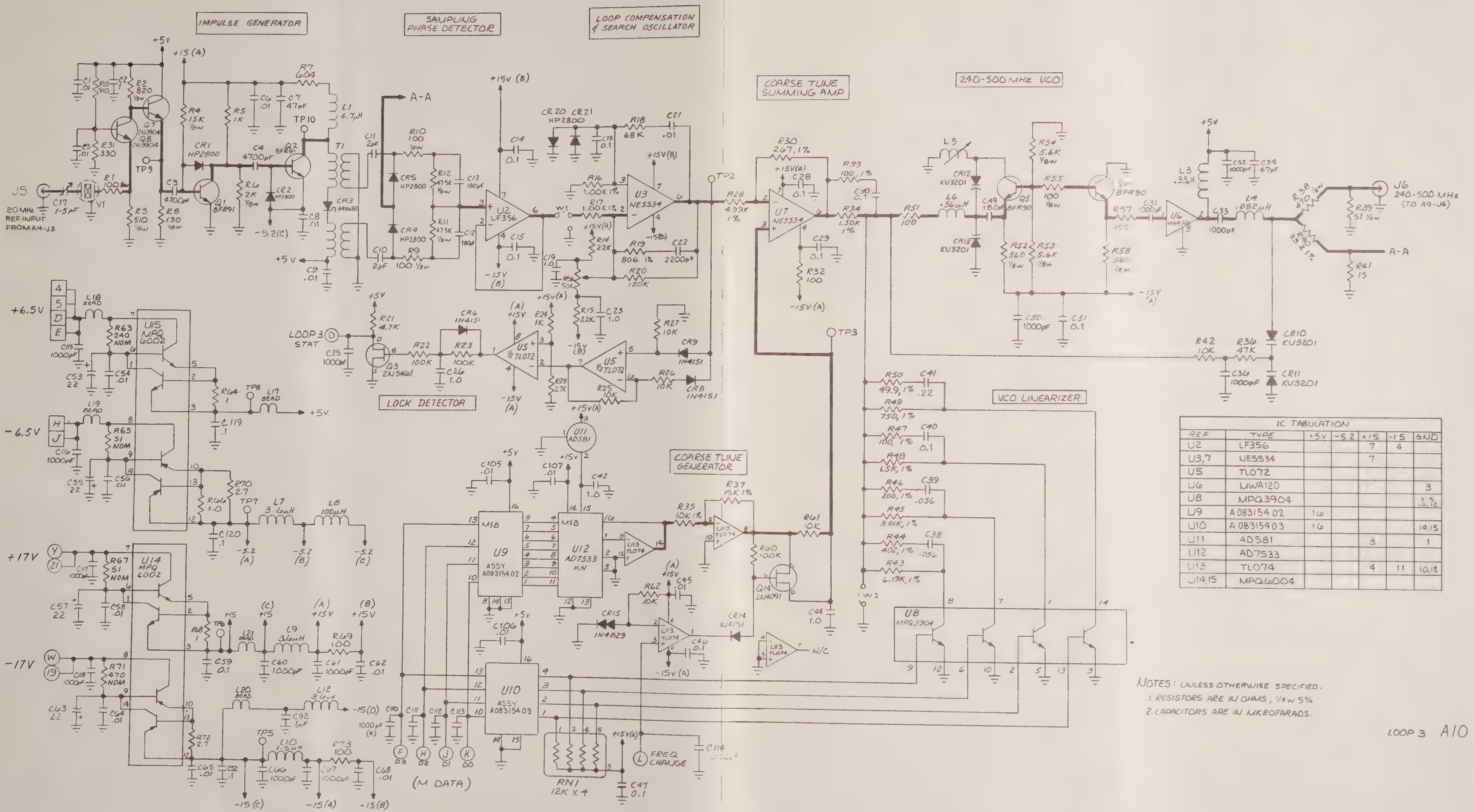
Figure 5-35. Loops 3 and 4 A10 Block Diagram


106
24 OR 26 AWG TINNED COPPER WIRE THROUGH FERRITE BEAD
DETAIL A
(FOR L17, L18, L19, L20, L21)
SOLDER JACKET TO P.C. BOARD
CR3 SOLDERED BETWEEN CENTER CONDUCTORS
P.C. BOARD
231
232
*NOTE 3
235
236
3 PLACES *
* 233
NOTE 6
* 5
4 *
229 230
23 PLACES *
J1
J2
J3
J4
J5
J6
RED
GRN
52542 ASSY 07749301 REV
DETAIL A 5 PLACES
234
238

NOTES:

1. INSTALL GLASS BEADS ONLY ON CAPS WHOSE LEADS ARE BENT.
2. ON CIRCUIT SIDE TRIM PINS ON J1 → J6.
3. R41 IS INSTALLED ON CIRCUIT SIDE AFTER FLOW SOLDER.
4. * DENOTES AFTER FLOW SOLDER PARTS.
5. SOLDER MASK ENTIRE GOLD PLATED OUTLINE OF SHIELD ④ ON SOLDER SIDE OF P.C.B. BEFORE LOADING.
6. MARK REV. LEVEL OF ASSY DRAWING WITH PERMANENT INK.

Figure 5-36. Loops 3 and 4 PC Board Assembly A10

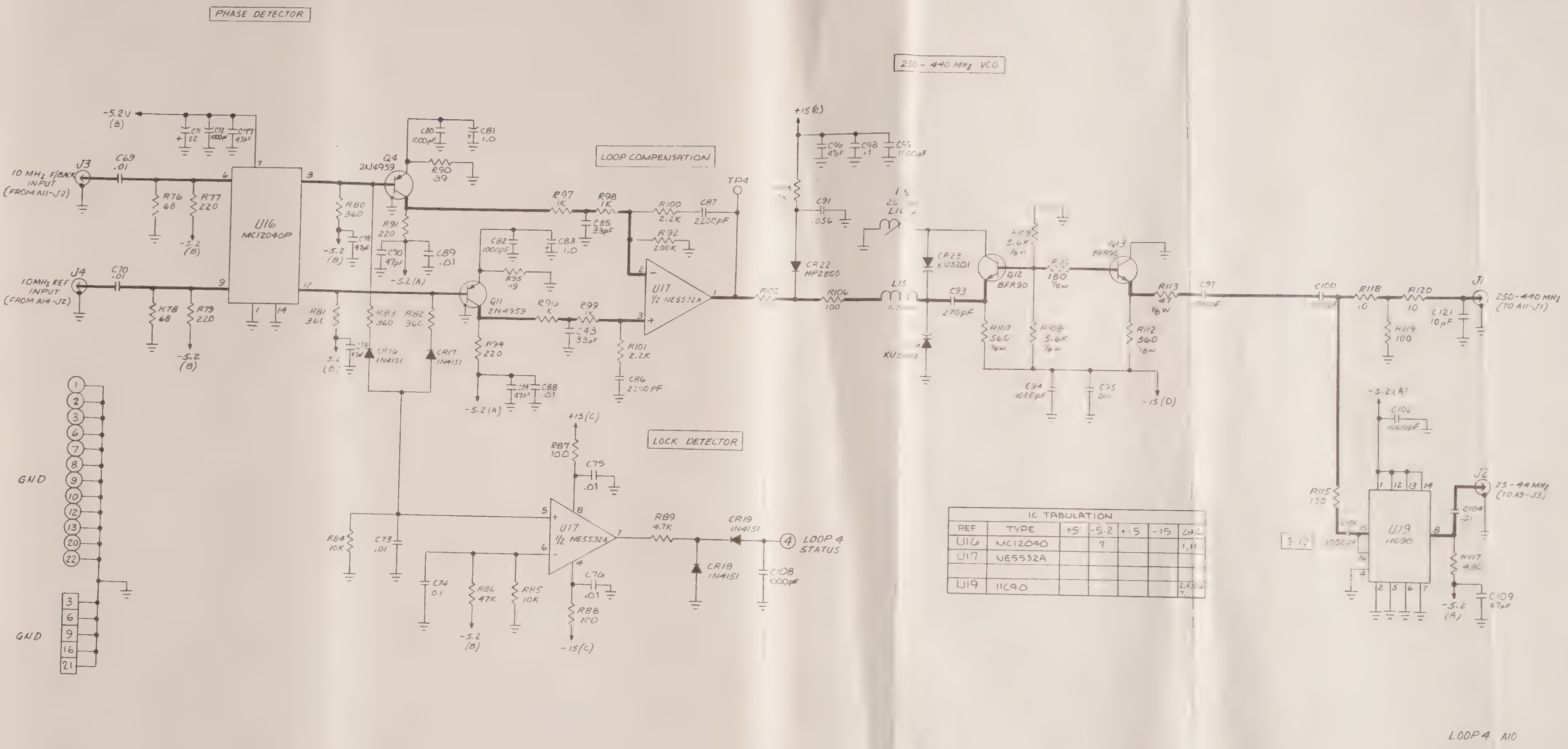

IMPULSE GENERATOR
SAMPLING PHASE DETECTOR
LOOP COMPENSATION & SEARCH OSCILLATOR
COARSE TUNE SUMMING AMP
240-500 MHz VCO
LOCK DETECTOR
COARSE TUNE GENERATOR
VCO LINEARIZER
J5
20 MHz REF INPUT FROM A14-J3
J6
240-500 MHz (TO A9-J4)
A-A
TP2
TP3
TP5
TP6
TP7
TP8
TP9
TP10
LOOP 3 STAT
FREQ CHANGE
(M DATA)
D8
D2
D1
D0
+6.5V
-6.5V
+17V
-17V
U2 LF356
U3 NE5534
U5 1/2 TL072
U6 MWA120
U7 NE5534
U8 MPQ3904
U9 ASSY A08315402
U10 ASSY A08315403
U11 AD581
U12 AD7533 KN
U13 TL074
U14 MPQ6002
U15 MPQ6002
RN1 12K X 4
+5V
+15V
-15V
-5.2(A)
-5.2(B)
-5.2(C)
-15(A)
-15(B)
-15(C)
-15(D)
N/C
W1
W2

IC TABULATION						
REF	TYPE	+5V	-5.2	+15	-15	GND
U2	LF356			7	4	
U3,7	NE5534			7		
U5	TL072					
U6	MWA120					3
U8	MPQ3904					3, 5 10, 12
U9	A 08315402	16				
U10	A 08315403	16				14,15
U11	AD581			3		1
U12	AD7533					
U13	TL074			4	11	10,12
U14,15	MPQ6004					

NOTES: UNLESS OTHERWISE SPECIFIED.
1. RESISTORS ARE IN OHMS, 1/4W 5%
2. CAPACITORS ARE IN MICROFARADS.

LOOP 3 A10

Figure 5-37. Loops 3 and 4 A10 Schematic (Sheet 1 of 2)


PHASE DETECTOR
250 - 440 MHz VCO
LOOP COMPENSATION
LOCK DETECTOR
-5.2V (B)
C71 22
C72 1000pF
C77 47pF
10 MHz F/BACK INPUT (FROM A11-J2)
J3
C69 .01
R76 68
R77 220
-5.2 (B)
U16 MC12040P
10MHz REF INPUT (FROM A14-J2)
J4
C70 .01
R78 68
R79 220
Q4 2N4959
C80 1000pF
C81 1.0
R90 39
R80 360
R91 220
C78 47pF
C90 47pF
C89 .01
-5.2 (A)
R81 360
R83 360
R82 360
CR16 1N4151
CR17 1N4151
Q11 2N4959
C82 1000pF
C83 1.0
R95 49
R97 1K
R98 1K
C85 33pF
R96 1K
R99 1K
C43 33pF
R94 220
C84 47pF
C88 .01
-5.2 (A)
R100 2.2K
C87 2200pF
R92 200K
TP4
U17 1/2 NE5532A
R101 2.2K
C86 2200 PF
+15 (C)
C96 47pF
C98 .1
C91 .056
CR22 HP2800
R102
R106 100
L15
CR23 KU3201
C93 270pF
Q12 BFR90
R109 5.6K 1/8W
R107 560 1/8W
R108 5.6K 1/8W
180 1/8W
Q13 BFR90
R113 47 1/8W
R112 560 1/8W
C94 1000pF
-15 (D)
C97
C100
R118 10
R120 10
R119 100
C121 10pF
J1
250-440 MHz (TO A11-J1)
-5.2 (A)
C102 1000pF
R115 130
U19 11C90
J2
25-44 MHz (TO A9-J3)
C104 .01
R117 430
C109 47pF
-5.2 (A)
R87 100
C75 .01
U17 1/2 NE5532A
R89 4.7K
CR19 1N4151
4 LOOP 4 STATUS
CR18 1N4151
C108 1000pF
R84 10K
C73 .01
C74 0.1
R86 47K
R85 10K
-5.2 (B)
C76 .01
R88 100
-15 (C)
GND
1 2 3 6 7 8 9 10 12 13 20 22
GND
3 6 9 16 21
LOOP 4 A10

IC TABULATION						
REF	TYPE	+5	-5.2	+15	-15	GND
U16	MC12040		7			1,14
U17	NE5532A					
U19	11C90					2,4,5,6 7,

Figure 5-37. Loops 3 and 4 A10 Schematic (Sheet 2 of 2)

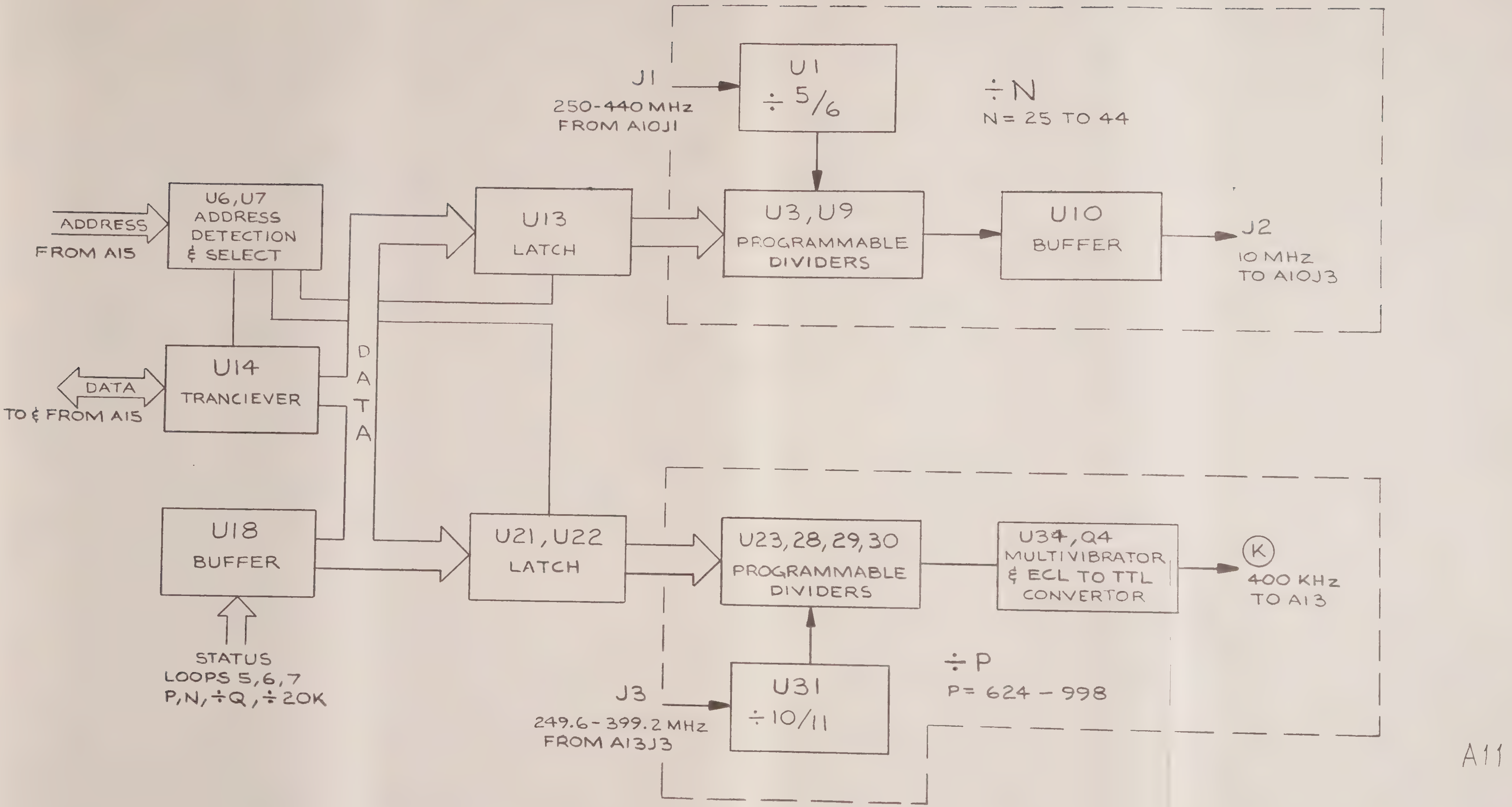
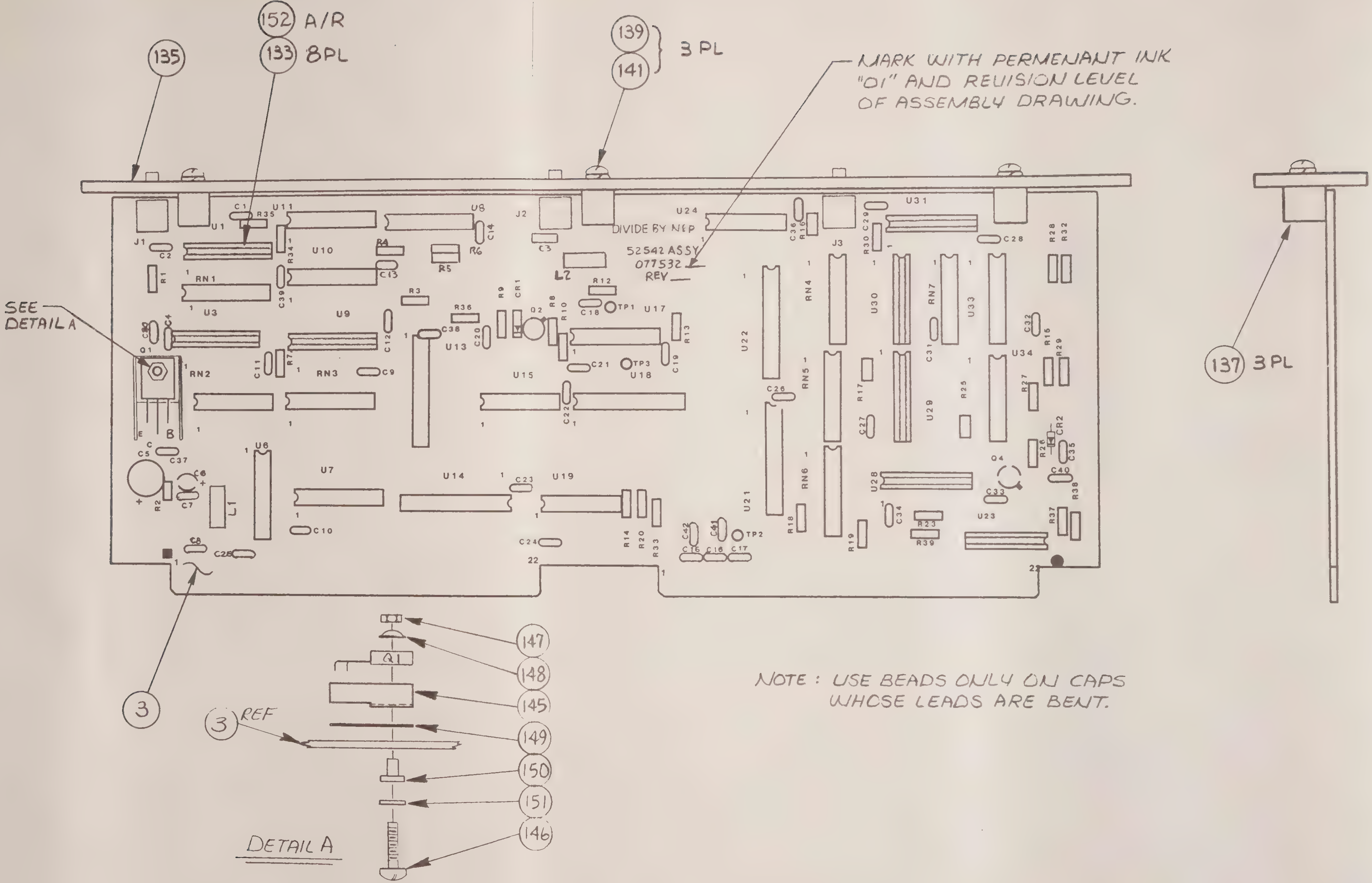

J1
250-440 MHz
FROM A10J1
U1
÷ 5/6
÷N
N = 25 TO 44
ADDRESS
FROM A15
U6, U7
ADDRESS
DETECTION
& SELECT
U13
LATCH
U3, U9
PROGRAMMABLE
DIVIDERS
U10
BUFFER
J2
10 MHz
TO A10J3
DATA
TO & FROM A15
U14
TRANCIEVER
D
A
T
A
U18
BUFFER
U21, U22
LATCH
U23, 28, 29, 30
PROGRAMMABLE
DIVIDERS
U34, Q4
MULTIVIBRATOR
& ECL TO TTL
CONVERTOR
K
400 KHz
TO A13
STATUS
LOOPS 5, 6, 7
P, N, ÷Q, ÷20K
J3
249.6-399.2 MHz
FROM A13J3
U31
÷10/11
÷P
P = 624 - 998
A11

Figure 5-38. Divide-by-N and Divide-by-P A11 Block Diagram


152 A/R
133 8PL
135
139
141
3 PL
SEE DETAIL A
137 3 PL
3
DIVIDE BY N&P
52542 ASSY
077532
REV
J1
J2
J3
U1
U3
U6
U7
U8
U9
U10
U11
U13
U14
U15
U17
U18
U19
U21
U22
U23
U24
U28
U29
U30
U31
U33
U34
RN1
RN2
RN3
RN4
RN5
RN6
RN7
Q1
Q2
Q4
L1
L2
CR1
CR2
TP1
TP2
TP3
E
B
C
22
147
148
145
149
150
151
146
3 REF
DETAIL A

MARK WITH PERMENANT INK "01" AND REVISION LEVEL OF ASSEMBLY DRAWING.

NOTE: USE BEADS ONLY ON CAPS WHOSE LEADS ARE BENT.

Figure 5-39. Divide-by-N and Divide-by-P PC Board Assembly A11

REF	+5V	-5.3V	GND
U1,31		12, 13	4,5
U3,8,9,10,11, 23, U28,29,30,33,34		8	1, 16
U6,7,17,24	16		8
U13,14,18,21,22	20		10
U15,19	14		7

NOTES: UNLESS OTHERWISE SPECIFIED
1) RESISTORS ARE IN OHMS ¼w 5% CARBON COMPOSITION.
2) CAPACITORS ARE IN MICRO-FARADS.

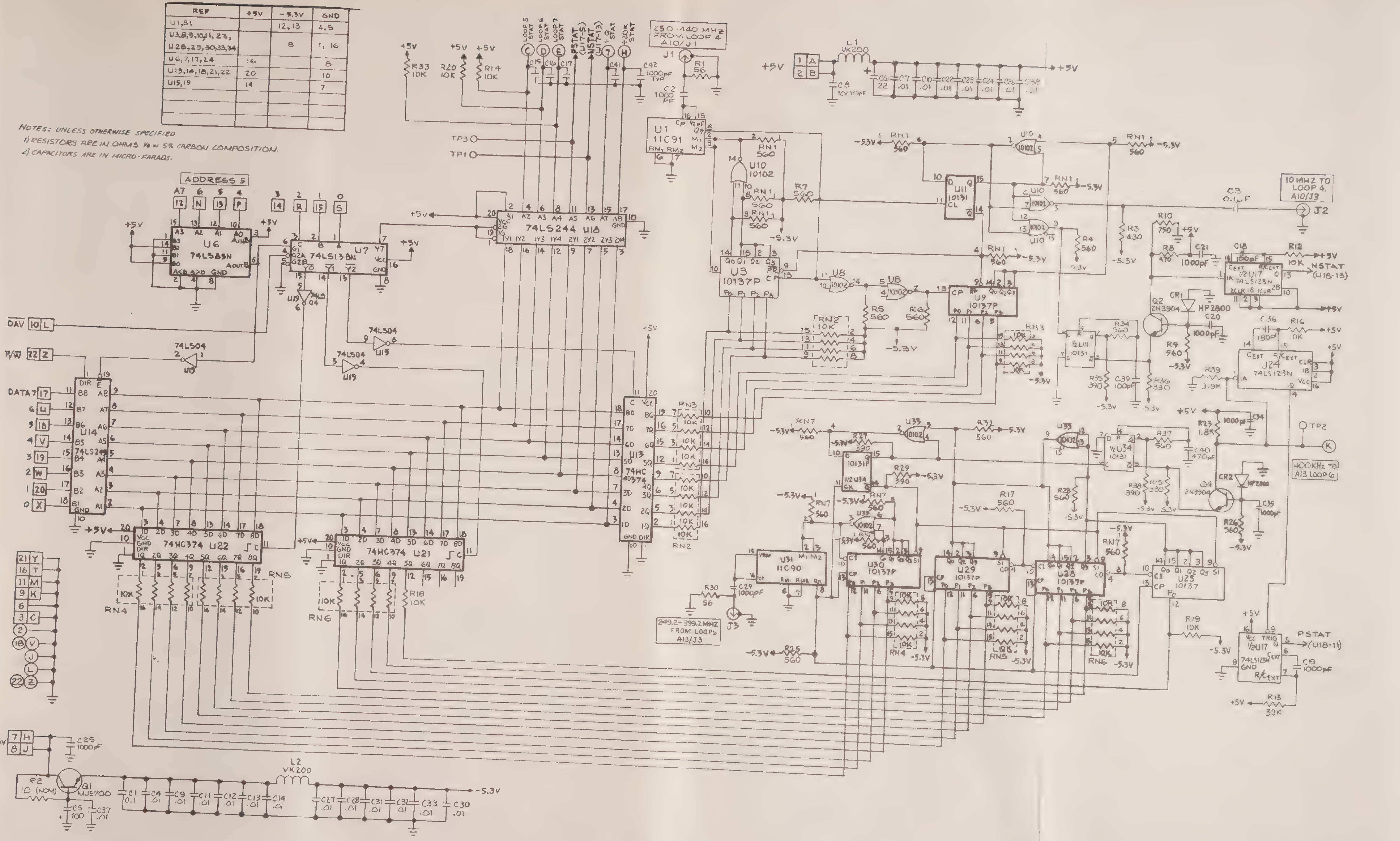

ADDRESS 5
U6 74LS85N
U7 74LS138N
U18 74LS244
U14 74LS245
U13 74HC374
U22 74HC374
U21 74HC374
U19 74LS04
U15 74LS04
U1 11C91
U3 10137P
U9 10137P
U10 10102
U8 10102
U11 10131
U17 74LS123N
U24 74LS123N
U31 11C90
U30 10137P
U29 10137P
U28 10137P
U23 10137
U33 10102
U34 10131
Q1 MJE700
Q2 2N3904
Q4 2N3904
CR1 HP2800
CR2 HP2800
L1 VK200
L2 VK200
250-440 MHz FROM LOOP 4 A10/J1
10 MHZ TO LOOP 4, A10/J3
249.2-399.2 MHZ FROM LOOP6 A13/J3
400KHz TO A13 LOOP 6
J1
J2
J3
TP1
TP2
TP3
DAV
R/W
DATA7
NSTAT (U18-13)
PSTAT (U18-11)
LOOP 5 STAT
LOOP 6 STAT
LOOP 7 STAT
PSTAT (U17-5)
NSTAT (U17-13)
I-Q STAT
+20K STAT
+5V
-5.3V
-65V
RN1 560
RN2 10K
RN3 10K
RN4 10K
RN5 10K
RN6 10K
RN7 560
R1 56
R2 10 (NOM)
R3 430
R4 560
R5 560
R6 560
R7 560
R8 470
R9 560
R10 750
R12 10K
R13 39K
R14 10K
R15 330
R16 10K
R17 560
R18 10K
R19 10K
R20 10K
R23 1.8K
R25 560
R26 560
R27 390
R28 560
R29 390
R30 56
R32 560
R33 10K
R34 560
R35 390
R36 330
R37 560
R38 390
R39 3.9K
C2 1000 PF
C3 0.1µF
C5 100
C8 1000pF
C19 1000pF
C20 1000pF
C21 1000pF
C25 1000pF
C29 1000pF
C34 1000pF
C35 1000pF
C39 100pF
C40 470pF
C42 1000pF TYP
C56 180PF
C18 100pF

Figure 5-40. Divide-by-N and Divide-by-P A11 Schematic

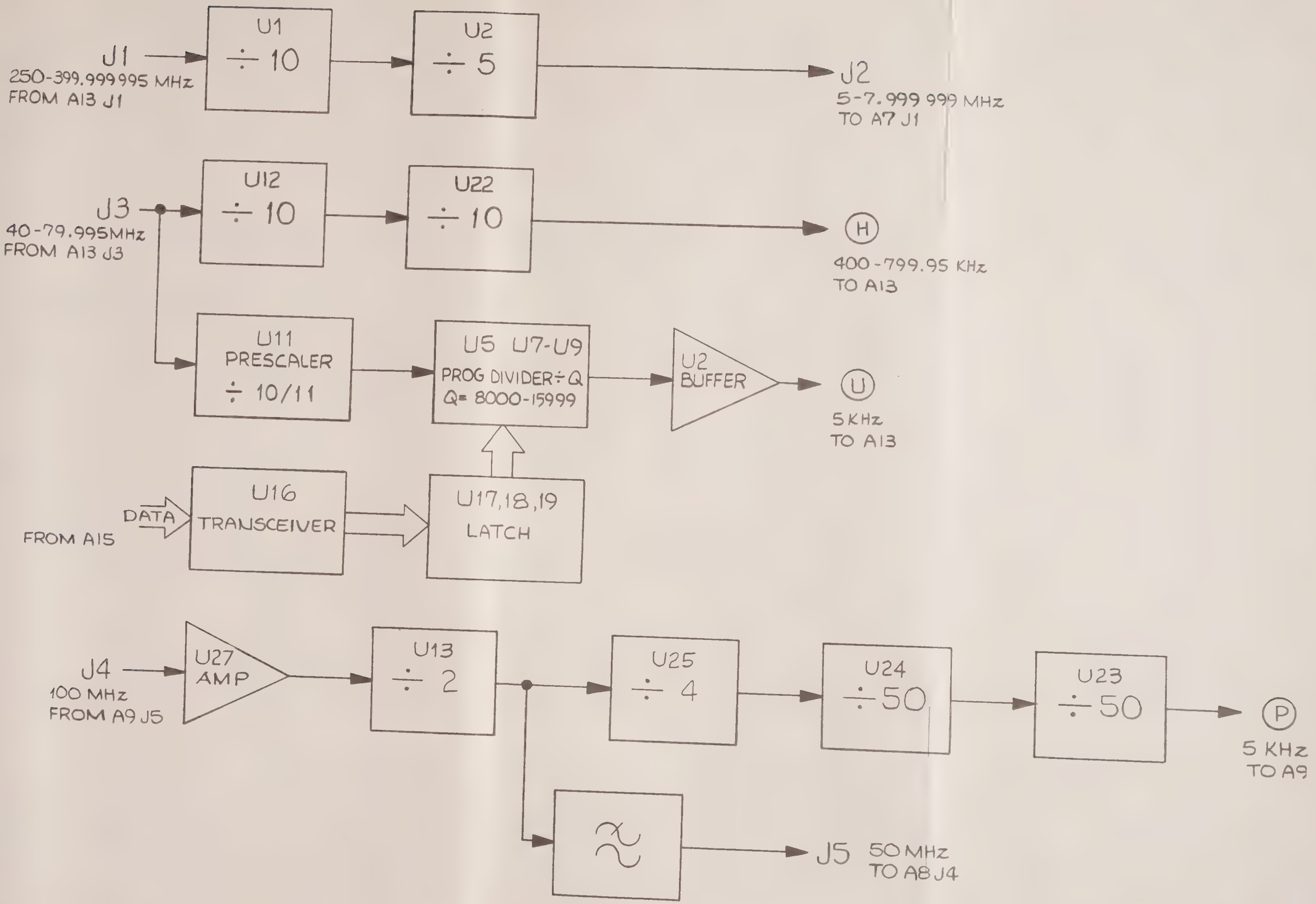
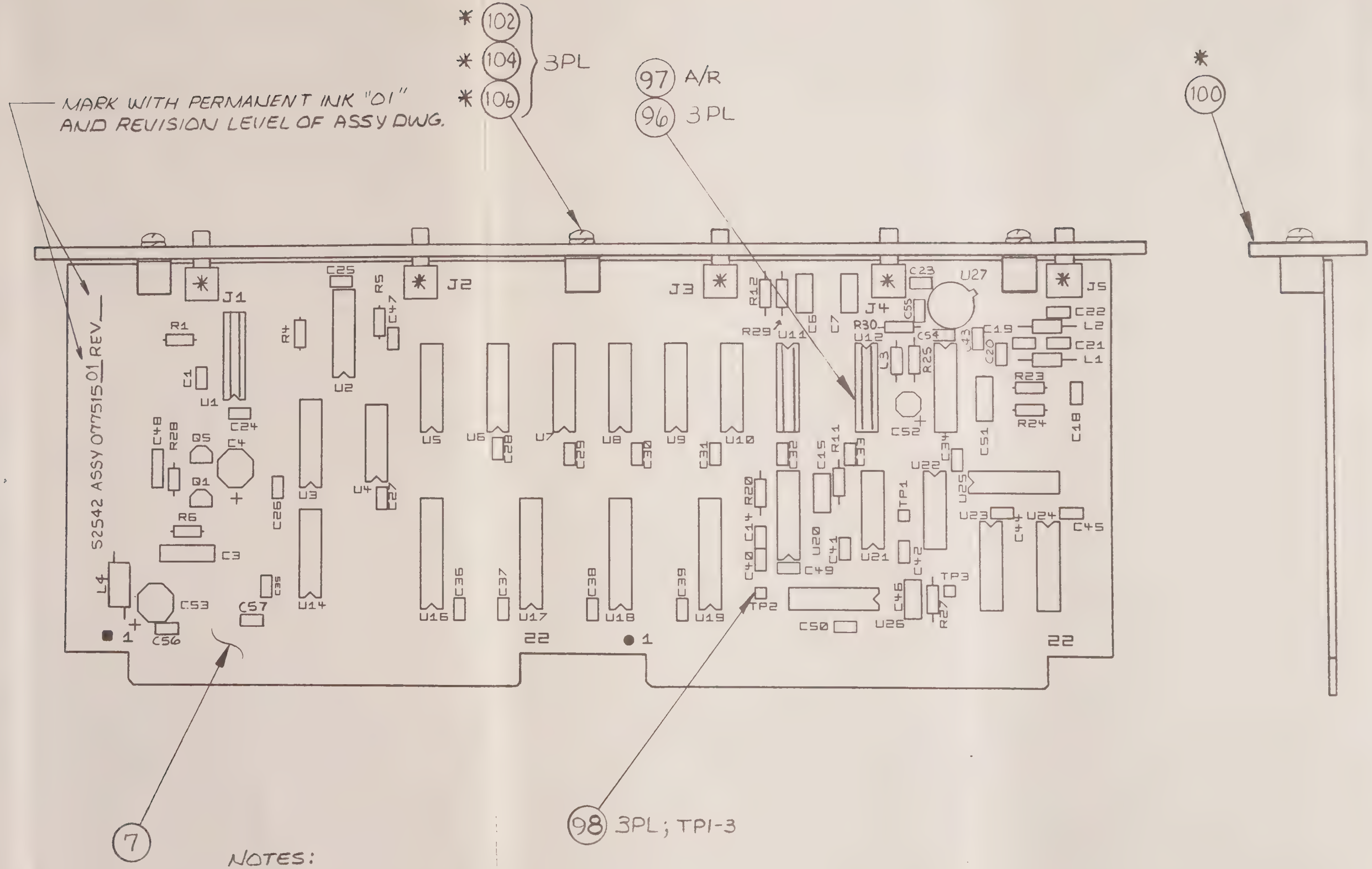

J1
250-399.999995 MHz
FROM A13 J1
U1
÷ 10
U2
÷ 5
J2
5-7.999 999 MHz
TO A7 J1
J3
40-79.995MHz
FROM A13 J3
U12
÷ 10
U22
÷ 10
H
400-799.95 KHz
TO A13
U11
PRESCALER
÷ 10/11
U5 U7-U9
PROG DIVIDER÷Q
Q= 8000-15999
U2
BUFFER
U
5 KHz
TO A13
DATA
FROM A15
U16
TRANSCEIVER
U17,18,19
LATCH
J4
100 MHz
FROM A9 J5
U27
AMP
U13
÷ 2
U25
÷ 4
U24
÷50
U23
÷50
P
5 KHz
TO A9
J5
50 MHz
TO A8 J4

Figure 5-41. Divide-by-Q A12 Block Diagram

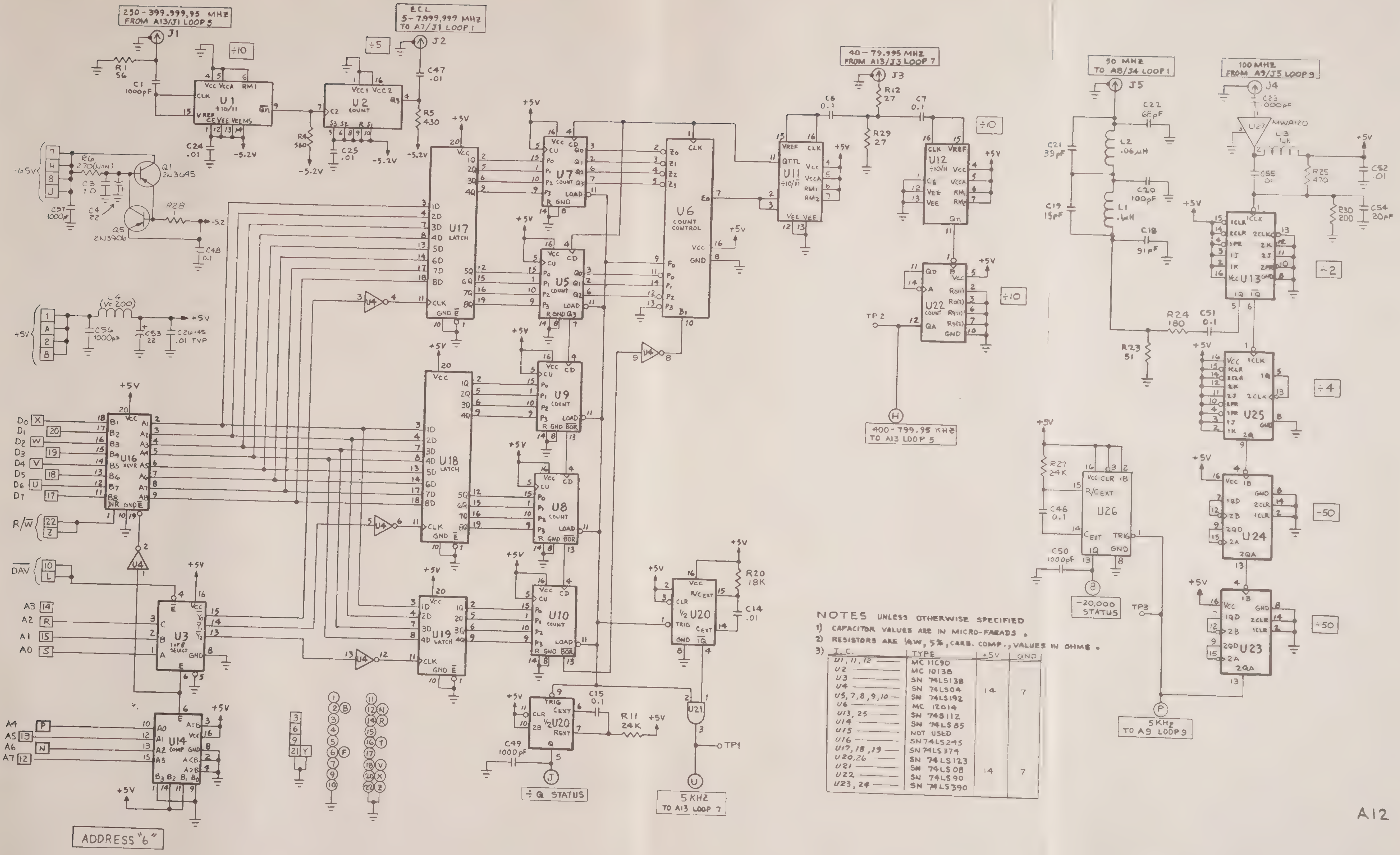


MARK WITH PERMANENT INK "01"
AND REVISION LEVEL OF ASSY DWG.
* 102
* 104
* 106
3PL
97 A/R
96 3PL
* 100
S2542 ASSY 077515 01 REV __
J1
J2
J3
J4
J5
R1
R4
R5
C47
C25
U1
U2
C1
C24
C48
R28
Q5
C4
Q1
R6
C3
L4
C53
C56
C57
C35
C26
U3
U4
C27
U14
U5
U6
C28
U7
C29
U8
C30
U9
U10
C31
U11
R12
R29
C6
C7
R30
U12
C55
C54
C23
U27
C22
L2
C19
C20
J3
C21
L1
L3
R25
R23
R24
C18
C52
C51
C34
U22
U25
C33
R11
C15
C32
R20
C14
C40
U20
C41
U21
TP1
C42
U23
U24
C44
C45
C49
TP3
C46
R27
U26
TP2
C50
U16
C36
C37
U17
C38
U18
C39
U19
1
22
1
22
7
98 3PL; TP1-3

NOTES:

1. USE GLASS BEADS ONLY ON CAPS WHOSE LEADS ARE BENT.
2. ON CIRCUIT SIDE, TRIM LEADS ON J1-J4.
3. "*" DENOTES AFTER FLOWSOLDER PARTS.

Figure 5-42. Divide-by-Q PC Board Assembly A12


250 - 399.999,95 MHZ FROM A13/J1 LOOP 5
J1
ECL 5 - 7.999,999 MHZ TO A7/J1 LOOP 1
J2
÷10
÷5
U1 ÷10/11
U2 COUNT
R1 56
C1 1000pF
C24 .01
C25 .01
C47 .01
R4 560
R5 430
-5.2V
-65V
R6 270(NOM)
Q1 2N3645
Q5 2N3906
R28
C3 10
C4 22
C57 1000pF
C48 0.1
-5.2
L4 (VC 200)
C56 1000pF
C53 22
C26-45 .01 TYP
+5V
U17 LATCH
U18 LATCH
U19 LATCH
U16 XCVR
U7 COUNT
U5 COUNT
U9 COUNT
U8 COUNT
U10 COUNT
U6 COUNT CONTROL
U4
U3 1 OF 8 SELECT
U14 COMP
D0
D1
D2
D3
D4
D5
D6
D7
R/W
DAV
A3
A2
A1
A0
A4
A5
A6
A7
ADDRESS "6"
40 - 79.995 MHZ FROM A13/J3 LOOP 7
J3
C6 0.1
C7 0.1
R12 27
R29 27
U11 ÷10/11
U12 ÷10/11
÷10
U22 COUNT
÷10
TP 2
400 - 799.95 KHZ TO A13 LOOP 5
½ U20
R20 18K
C14 .01
C15 0.1
R11 24K
C49 1000pF
÷ Q STATUS
U21
TP1
5 KHZ TO A13 LOOP 7
50 MHZ TO A8/J4 LOOP 1
J5
100 MHZ FROM A9/J5 LOOP 9
J4
C23 .000pF
U27 MWA120
L3 1µH
C22 68pF
C21 39pF
L2 .06µH
C20 100pF
C19 15pF
L1 .1µH
C18 91pF
C55 .01
R25 470
C52 .01
R30 200
C54 20pF
U13
÷2
R24 180
C51 0.1
R23 51
U25
÷4
R27 24K
C46 0.1
U26
C50 1000pF
÷20,000 STATUS
TP3
5 KHz TO A9 LOOP 9
U24
÷50
U23
÷50
A12

NOTES UNLESS OTHERWISE SPECIFIED

1) CAPACITOR VALUES ARE IN MICRO-FARADS.

2) RESISTORS ARE ¼W, 5%, CARB. COMP., VALUES IN OHMS.

3)

I.C.	TYPE	+5V	GND
U1, 11, 12	MC 11C90		
U2	MC 10138		
U3	SN 74LS138		
U4	SN 74LS04	14	7
U5, 7, 8, 9, 10	SN 74LS192		
U6	MC 12014		
U13, 25	SN 74S112		
U14	SN 74LS85		
U15	NOT USED		
U16	SN 74LS245		
U17, 18, 19	SN 74LS374		
U20, 26	SN 74LS123		
U21	SN 74LS08	14	7
U22	SN 74LS90		
U23, 24	SN 74LS390		

Figure 5-43. Divide-by-Q A12 Schematic

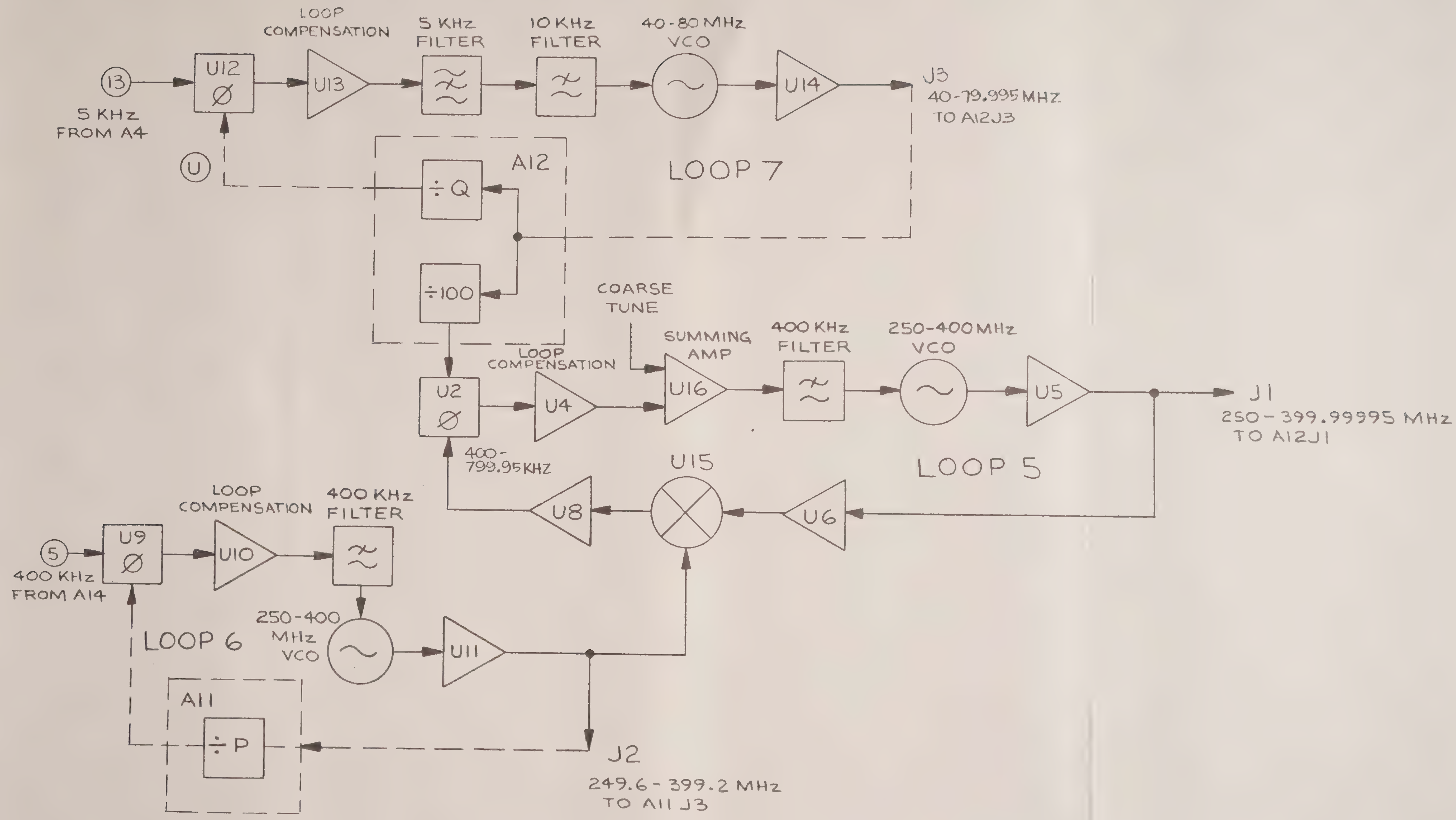
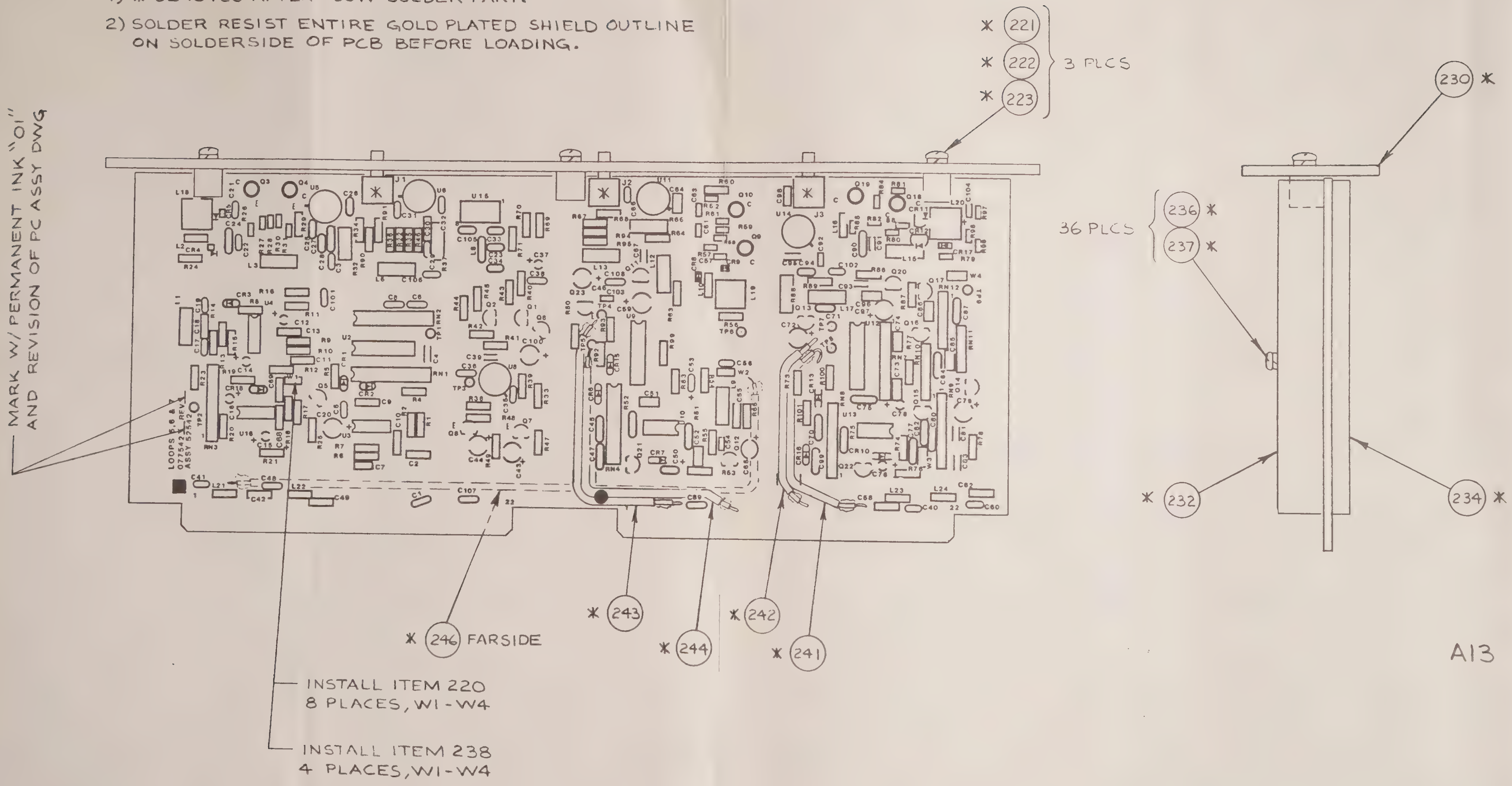

13
5 KHz
FROM A4
U12
Ø
LOOP
COMPENSATION
U13
5 KHz
FILTER
10 KHz
FILTER
40-80 MHz
VCO
U14
J3
40-79.995 MHZ
TO A12J3
U
A12
÷Q
LOOP 7
÷100
COARSE
TUNE
SUMMING
AMP
400 KHz
FILTER
250-400 MHz
VCO
LOOP
COMPENSATION
U2
Ø
U4
U16
U5
J1
250-399.99995 MHz
TO A12J1
400-
799.95 KHZ
U15
LOOP 5
U8
U6
LOOP
COMPENSATION
400 KHz
FILTER
5
400 KHz
FROM A14
U9
Ø
U10
250-400
MHz
VCO
U11
LOOP 6
A11
÷P
J2
249.6-399.2 MHz
TO A11 J3

Figure 5-44. Loops 5, 6, and 7 A13 Block Diagram

NOTES:

1) * DENOTES AFTER FLOW SOLDER PART.

2) SOLDER RESIST ENTIRE GOLD PLATED SHIELD OUTLINE ON SOLDERSIDE OF PCB BEFORE LOADING.

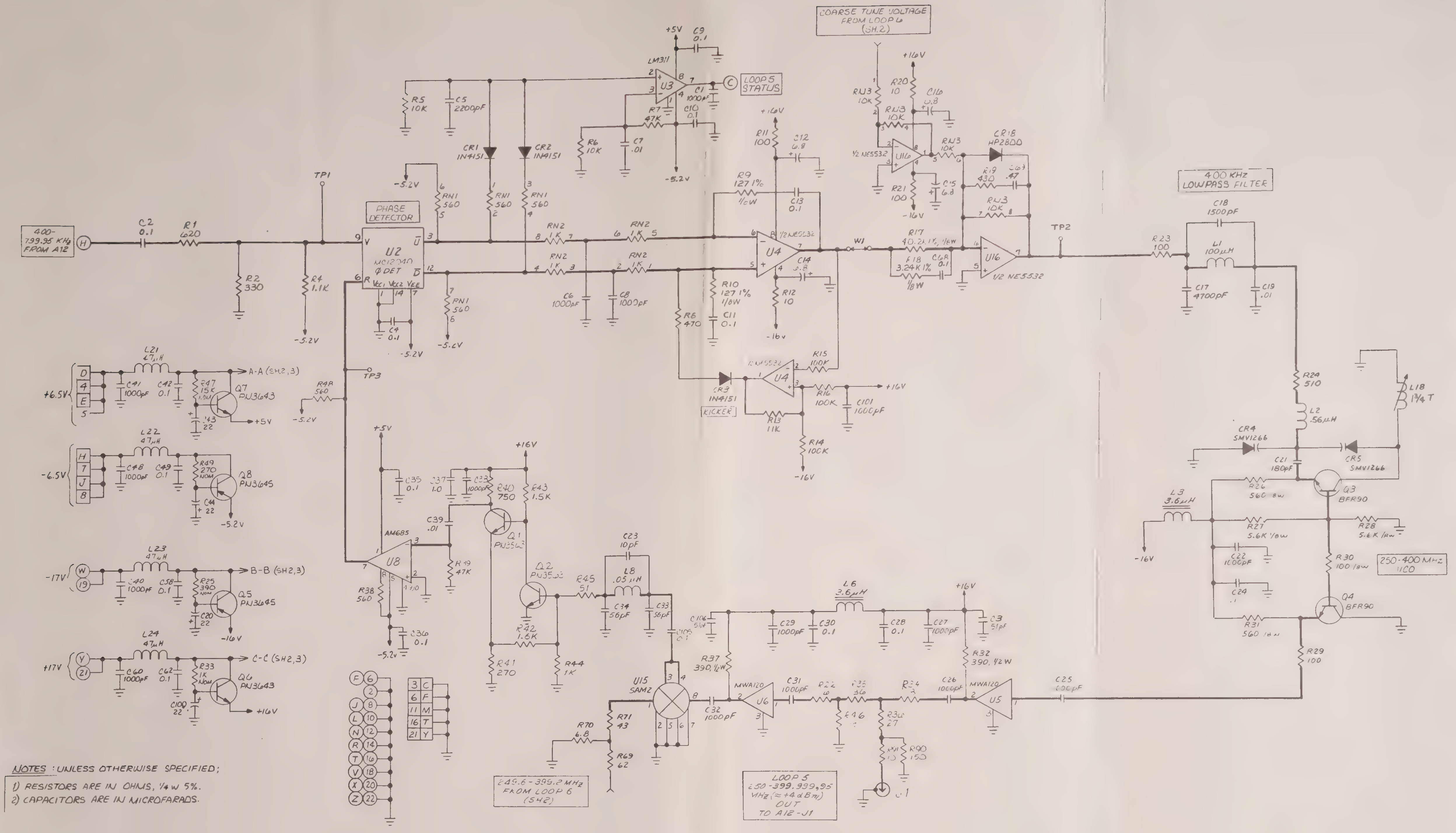

* 221
* 222
* 223
3 PLCS
230 *
36 PLCS
236 *
237 *
J1
J2
J3
LOOPS 5,6 & 7
07542
ASSY 52542
* 232
234 *
* 243
* 244
* 242
* 241
* 246 FARSIDE
A13

MARK W/ PERMANENT INK "01" AND REVISION OF PC ASSY DWG

INSTALL ITEM 220
8 PLACES, W1 - W4

INSTALL ITEM 238
4 PLACES, W1 - W4

Figure 5-45. Loops 5, 6, and 7 PC Board Assembly A13


400-799.95 KHz FROM A12
C2 0.1
R1 620
R2 330
R4 1.1K
TP1
PHASE DETECTOR
U2 MC12040 Φ DET
RN1 560
RN2 1K
CR1 1N4151
CR2 1N4151
R5 10K
C5 2200pF
LM311
U3
LOOP 5 STATUS
C1 1000pF
C9 0.1
R7 47K
C10 0.1
R6 10K
C7 .01
+5V
-5.2V
C6 1000pF
C8 1000pF
R9 127 1% 1/8W
C13 0.1
R11 100
C12 6.8
+16V
U4 1/2 NE5532
C14 6.8
R10 127 1% 1/8W
C11 0.1
R12 10
R8 470
-16V
CR3 1N4151 KICKER
R15 100K
R16 100K
C101 1000pF
R13 11K
R14 100K
COARSE TUNE VOLTAGE FROM LOOP 6 (SH.2)
RN3 10K
R20 10
C16 6.8
1/2 NE5532
U16
R21 100
C15 6.8
CR18 HP2800
R19 430
C63 .47
W1
R17 40.2K 1% 1/8W
R18 3.24K 1% 1/8W
C64 0.1
TP2
400 KHz LOWPASS FILTER
C18 1500pF
R23 100
L1 100μH
C17 4700pF
C19 .01
R24 510
L2 .56μH
L18 1¾T
CR4 SMV1266
CR5 SMV1266
C21 180pF
R26 560 1/8W
Q3 BFR90
L3 3.6μH
R27 5.6K 1/8W
R28 5.6K 1/8W
C22 1000pF
C24 1
R30 100 1/8W
250-400 MHz VCO
Q4 BFR90
R31 560 1/8W
R29 100
C25 1000pF
TP3
R48 560
L21 47μH
C41 1000pF
C42 0.1
R47 15K NOM
Q7 PN3643
C43 22
A-A (SH2,3)
+6.5V
L22 47μH
C48 1000pF
C49 0.1
R49 270 NOM
Q8 PN3645
C44 22
-6.5V
L23 47μH
C40 1000pF
C58 0.1
R25 390 NOM
Q5 PN3645
C20 22
B-B (SH2,3)
-17V
L24 47μH
C60 1000pF
C62 0.1
R33 1K NOM
Q6 PN3643
C100 22
C-C (SH2,3)
+17V
AM685
U8
C35 0.1
C37 1.0
C38 1000pF
R40 750
R43 1.5K
C39 .01
R39 47K
Q1 PN3563
Q2 PN3563
R38 560
C36 0.1
R45 51
C23 10pF
L8 .05μH
C34 56pF
C33 56pF
R42 1.6K
R41 270
R44 1K
U15 SAM2
R71 43
R70 6.8
R69 62
249.6-399.2 MHz FROM LOOP 6 (SH2)
C32 1000pF
R37 390 1/2W
MWA120
U6
C31 1000pF
L6 3.6μH
C29 1000pF
C30 0.1
C28 0.1
C27 1000pF
C3 51pF
R32 390 1/2W
U5
R34 27
R90 150
LOOP 5 250-399.999,95 MHz (≈ +4 dBm) OUT TO A12-J1
J1

NOTES: UNLESS OTHERWISE SPECIFIED;
1) RESISTORS ARE IN OHMS, 1/4 W 5%.
2) CAPACITORS ARE IN MICROFARADS.

Figure 5-46. Loops 5, 6, and 7 A13 Schematic (Sheet 1 of 3)

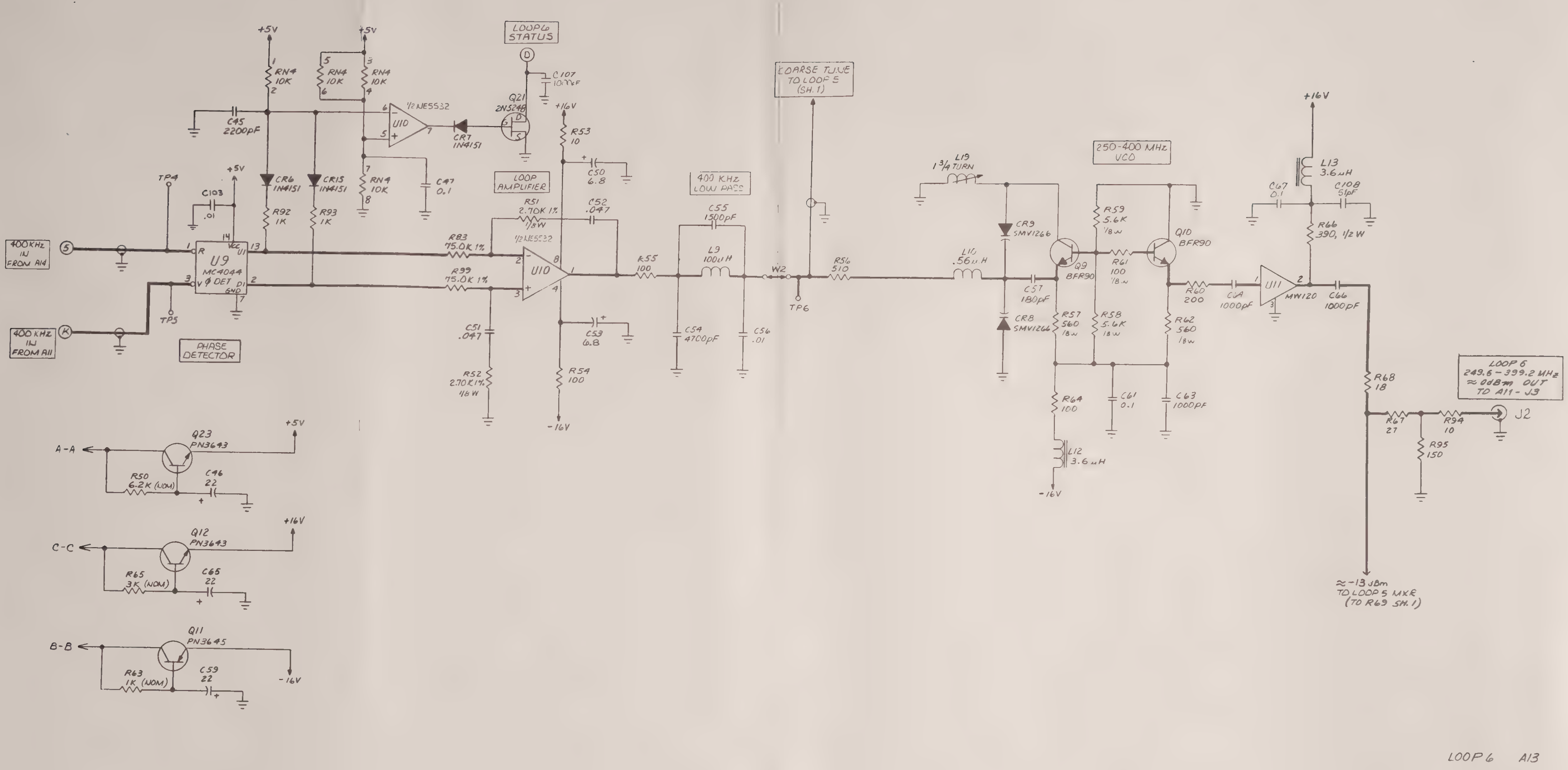

LOOP 6 STATUS
C107 1000pF
Q21 2N5248
CR7 1N4151
1/2 NE5532
U10
+5V
RN4 10K
C45 2200pF
C47 0.1
CR6 1N4151
CR15 1N4151
R92 1K
R93 1K
TP4
C103 .01
400 KHz IN FROM A14
400 KHz IN FROM A11
U9 MC4044 φ DET
TP5
PHASE DETECTOR
LOOP AMPLIFIER
R51 2.70K 1% 1/8W
C52 .047
R83 75.0K 1%
R99 75.0K 1%
C51 .047
R52 2.70K 1% 1/8W
+16V
R53 10
C50 6.8
C53 6.8
R54 100
-16V
R55 100
400 KHz LOW PASS
C55 1500pF
L9 100uH
C54 4700pF
C56 .01
W2
TP6
COARSE TUNE TO LOOP 5 (SH. 1)
R56 510
L19 1 3/4 TURN
L10 .56uH
CR9 SMV1266
CR8 SMV1266
C57 180pF
250-400 MHz VCO
Q9 BFR90
Q10 BFR90
R59 5.6K 1/8W
R61 100 1/8W
R57 560 1/8W
R58 5.6K 1/8W
R62 560 1/8W
R64 100
C61 0.1
C63 1000pF
L12 3.6uH
R60 200
C64 1000pF
U11 MW120
C66 1000pF
L13 3.6uH
C67 0.1
C108 51pF
R66 390, 1/2W
R68 18
R67 27
R94 10
R95 150
LOOP 6 249.6 - 399.2 MHz ≈ 0dBm OUT TO A11 - J3
J2
≈ -13 dBm TO LOOP 5 MXR (TO R69 SH. 1)
A-A
Q23 PN3643
R50 6.2K (NOM)
C46 22
C-C
Q12 PN3643
R65 3K (NOM)
C65 22
B-B
Q11 PN3645
R63 1K (NOM)
C59 22
LOOP 6 A13

Figure 5-46. Loops 5, 6, and 7 A13 Schematic (Sheet 2 of 3)

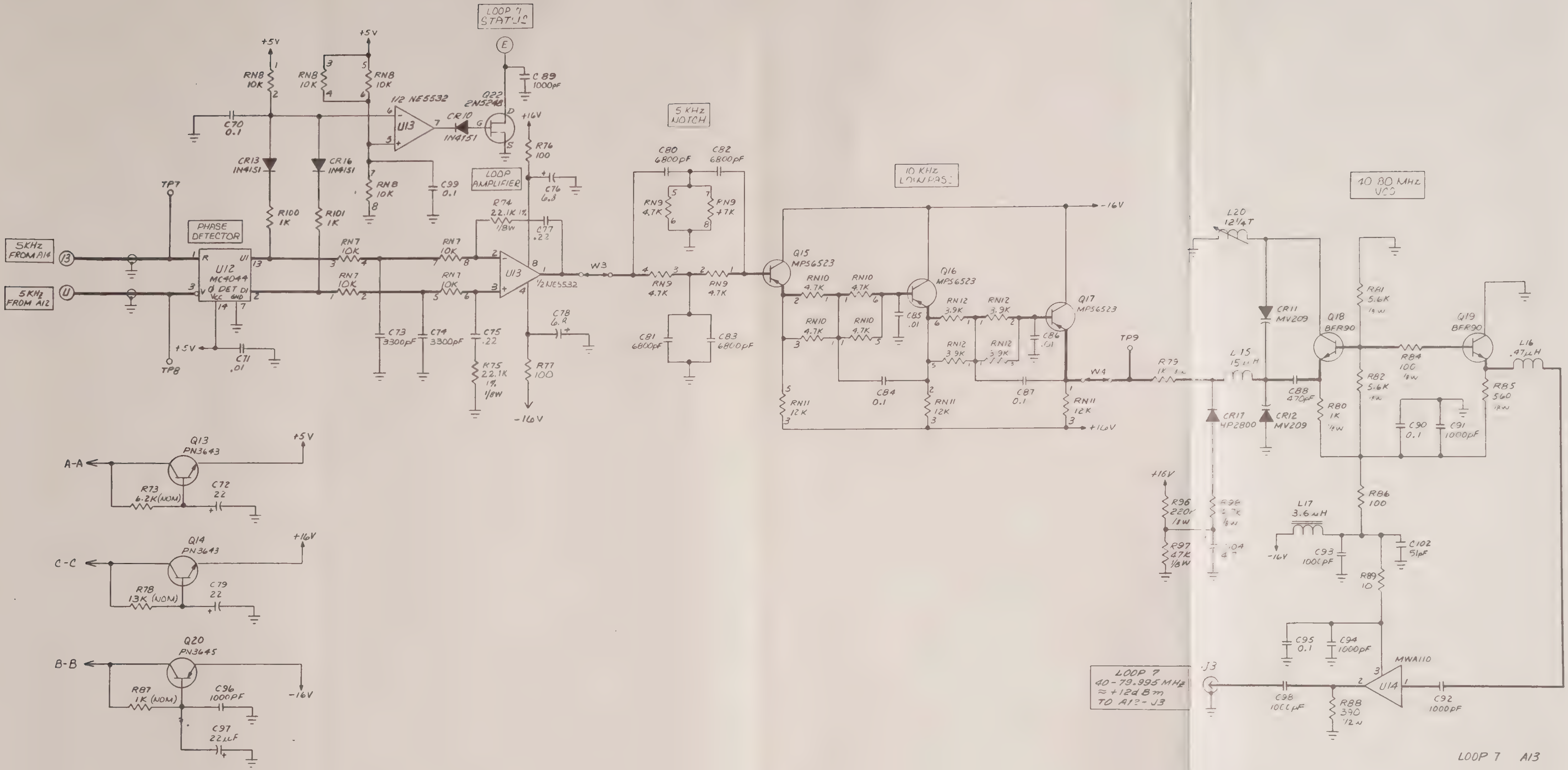

LOOP 7 STATUS
E
C89 1000pF
Q22 2N5248
D
G
S
+5V
RN8 10K
RN8 10K
RN8 10K
RN8 10K
1/2 NE5532
U13
CR10 1N4151
C70 0.1
CR13 1N4151
CR16 1N4151
C99 0.1
TP7
PHASE DETECTOR
R100 1K
R101 1K
5KHz FROM A14
5KHz FROM A12
U12 MC4044 Ø DET
R
V
U1
D1
VCC
GND
RN7 10K
RN7 10K
RN7 10K
RN7 10K
+5V
C71 .01
TP8
C73 3300pF
C74 3300pF
C75 .22
R75 22.1K 1% 1/8W
LOOP AMPLIFIER
R74 22.1K 1% 1/8W
C77 .22
+16V
R76 100
C76 6.8
C78 6.8
R77 100
-16V
1/2 NE5532
W3
5 KHz NOTCH
C80 6800pF
C82 6800pF
RN9 4.7K
RN9 4.7K
RN9 4.7K
RN9 4.7K
C81 6800pF
C83 6800pF
10 KHz LOWPASS
-16V
Q15 MPS6523
Q16 MPS6523
Q17 MPS6523
RN10 4.7K
RN10 4.7K
RN10 4.7K
RN10 4.7K
C85 .01
RN12 3.9K
RN12 3.9K
RN12 3.9K
RN12 3.9K
C86 .01
C84 0.1
C87 0.1
RN11 12K
RN11 12K
RN11 12K
+16V
TP9
W4
R79 1K
40-80 MHz VCO
L20 12 1/4 T
CR11 MV209
L15 15µH
C88 470pF
CR17 HP2800
CR12 MV209
Q18 BFR90
Q19 BFR90
R81 5.6K
R82 5.6K
R84 100
R80 1K
R85 560
L16 .47µH
C90 0.1
C91 1000pF
+16V
R96 220K 1/8W
R97 47K 1/8W
R86 100
L17 3.6µH
-16V
C93 1000pF
C102 51pF
R89 10
C95 0.1
C94 1000pF
MWA110
U14
J3
LOOP 7 40-79.995 MHz ≈ +12dBm TO A12-J3
C98 1000pF
R88 390
C92 1000pF
LOOP 7 A13
A-A
Q13 PN3643
+5V
R73 6.2K(NOM)
C72 22
C-C
Q14 PN3643
+16V
R78 13K (NOM)
C79 22
B-B
Q20 PN3645
-16V
R87 1K (NOM)
C96 1000PF
C97 22µF

Figure 5-46. Loops 5, 6, and 7 A13 Schematic (Sheet 3 of 3)

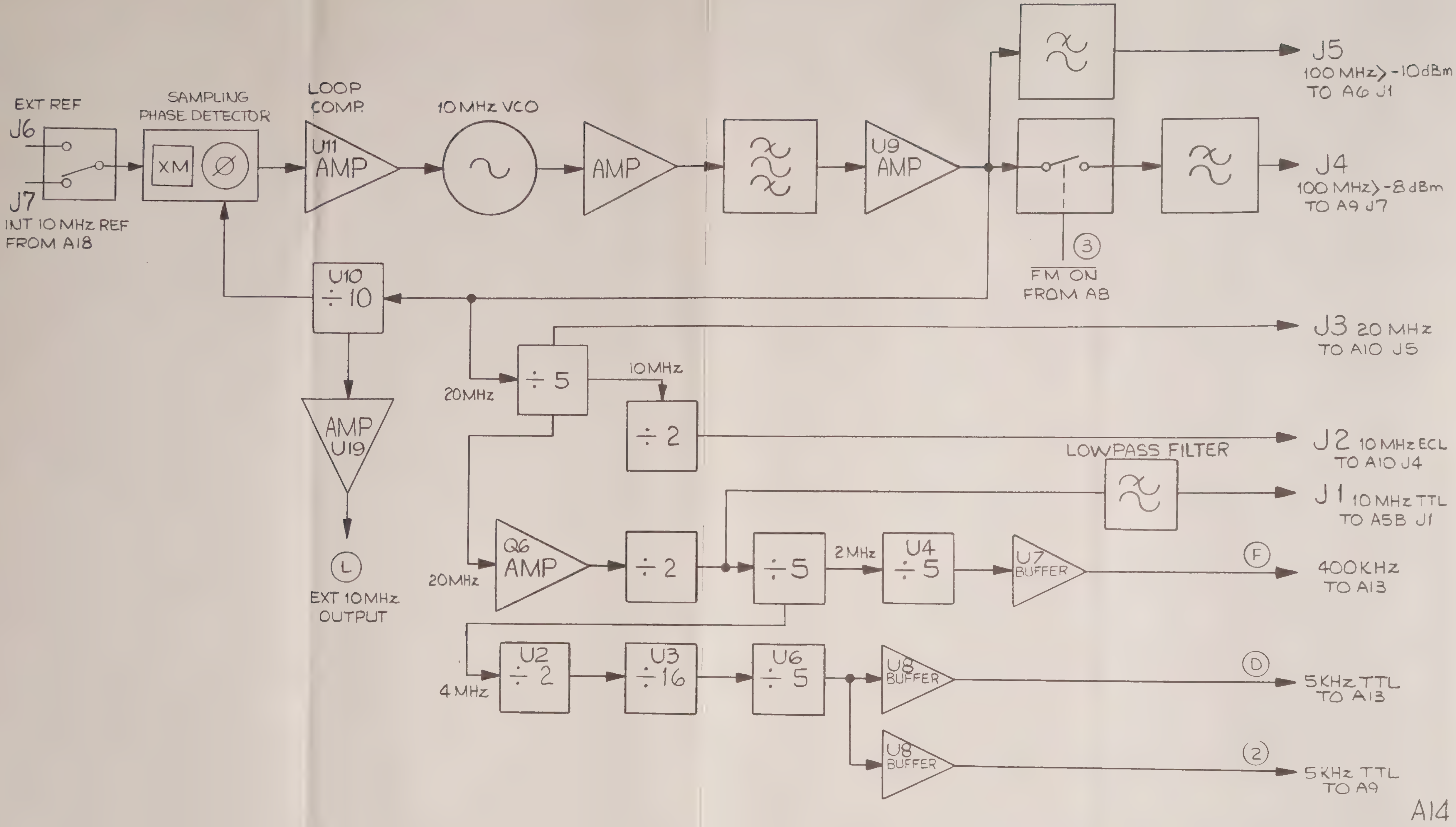
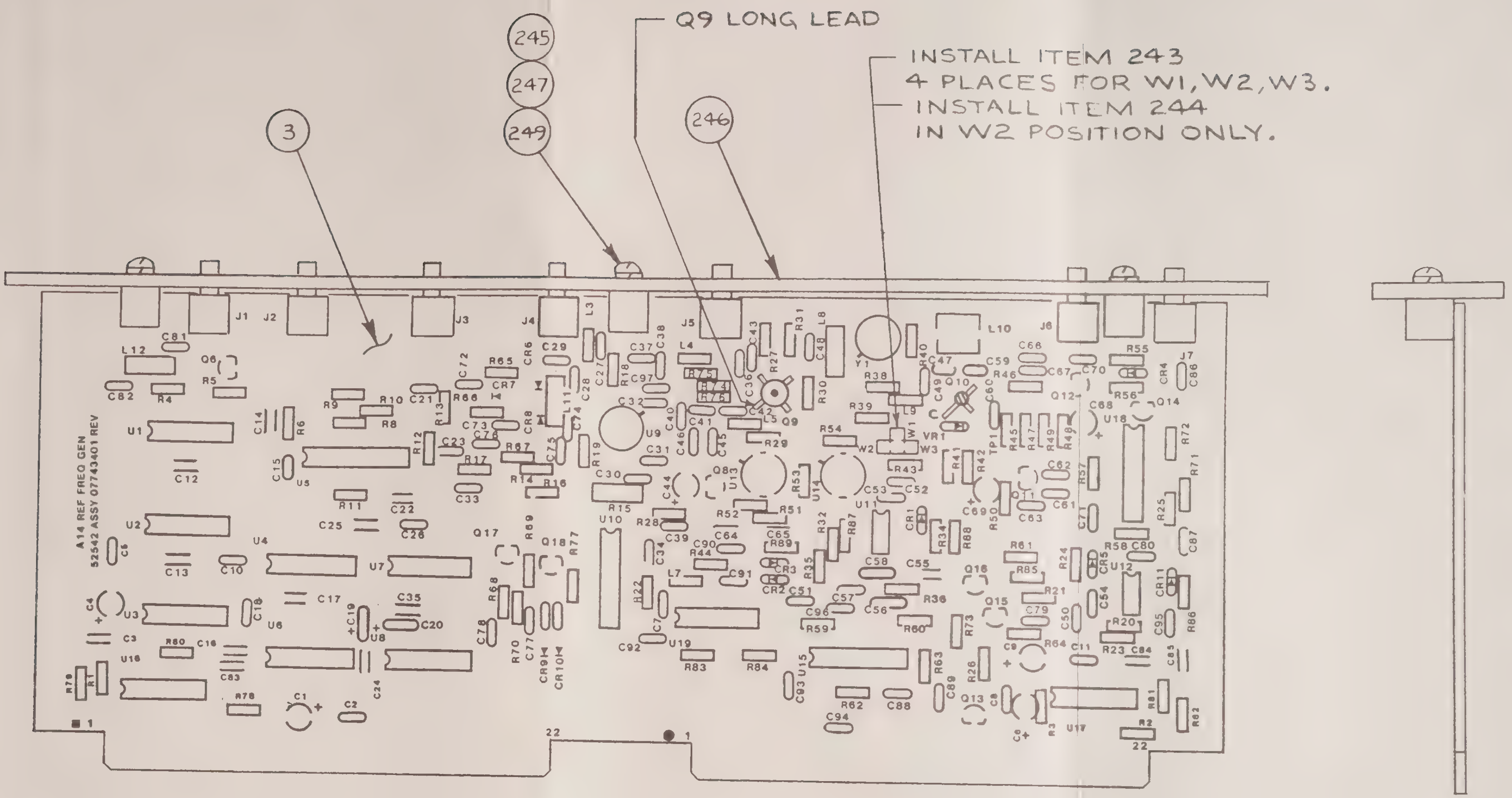

EXT REF
J6
J7
INT 10 MHz REF
FROM A18
SAMPLING
PHASE DETECTOR
XM
Ø
LOOP
COMP.
U11
AMP
10 MHz VCO
AMP
U9
AMP
J5
100 MHz>-10dBm
TO A6 J1
J4
100 MHz>-8 dBm
TO A9 J7
③
FM ON
FROM A8
U10
÷10
AMP
U19
Ⓛ
EXT 10MHz
OUTPUT
20MHz
÷5
10MHz
÷2
J3 20 MHz
TO A10 J5
J2 10 MHz ECL
TO A10 J4
LOWPASS FILTER
J1 10 MHz TTL
TO A5B J1
20MHz
Q6
AMP
÷2
÷5
2 MHz
U4
÷5
U7
BUFFER
Ⓕ
400KHz
TO A13
4 MHz
U2
÷2
U3
÷16
U6
÷5
U8
BUFFER
Ⓓ
5KHz TTL
TO A13
U8
BUFFER
②
5KHz TTL
TO A9
A14

Figure 5-47. Reference Frequency Generator A14 Block Diagram


245
247
249
3
246
A14 REF FREQ GEN
52542 ASSY 07743401 REV
J1
J2
J3
J4
J5
J6
J7
Q9
Y1
U1
U2
U3
U4
U7
U10
U17
W1
W2
W3
1
22

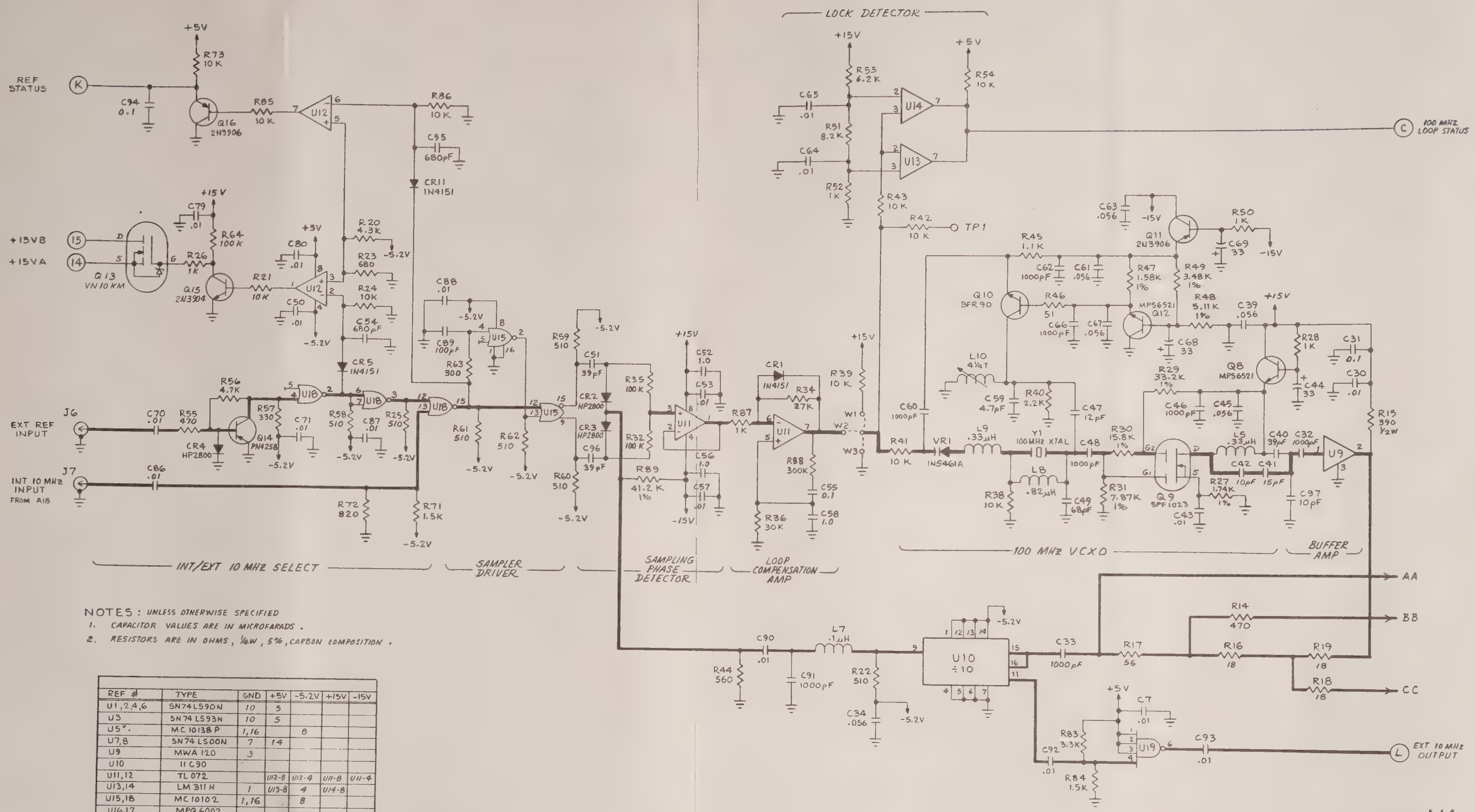
Q9 LONG LEAD

INSTALL ITEM 243
4 PLACES FOR W1, W2, W3.

INSTALL ITEM 244
IN W2 POSITION ONLY.

(P.C. BD. A/W REV. E)

Figure 5-48. Reference Frequency Generator PC Board Assembly A14


LOCK DETECTOR
INT/EXT 10 MHz SELECT
SAMPLER DRIVER
SAMPLING PHASE DETECTOR
LOOP COMPENSATION AMP
100 MHz VCXO
BUFFER AMP
REF STATUS
K
+15VB
+15VA
15
14
Q13 VN10KM
Q15 2N3904
Q16 2N3906
EXT REF INPUT
J6
INT 10 MHz INPUT FROM A18
J7
C
100 MHz LOOP STATUS
TP1
AA
BB
CC
L
EXT 10 MHz OUTPUT
U10 ÷10
Y1 100 MHz XTAL
VR1 1N5461A
Q9 SPF1023
Q10 BFR90
Q11 2N3906
Q12 MPS6521
Q8 MPS6521
Q14 PN4258
CR2 HP2800
CR3 HP2800
CR4 HP2800
CR1 1N4151
CR5 1N4151
CR11 1N4151
U9
U11
U12
U13
U14
U15
U18
U19
W1
W2
W3
A14

NOTES: UNLESS OTHERWISE SPECIFIED

1. CAPACITOR VALUES ARE IN MICROFARADS.
2. RESISTORS ARE IN OHMS, 1/4W, 5%, CARBON COMPOSITION.

REF #	TYPE	GND	+5V	-5.2V	+15V	-15V
U1,2,4,6	SN74LS90N	10	5			
U3	SN74LS93N	10	5			
U5*.	MC10138P	1,16		8		
U7,8	SN74LS00N	7	14			
U9	MWA120	3				
U10	11C90					
U11,12	TL072		U12-8	U12-4	U11-8	U11-4
U13,14	LM311H	1	U13-8	4	U14-8	
U15,18	MC10102	1,16		8		
U16,17	MPQ6002					
U19	SN74S140	7	14			

Figure 5-49. Reference Frequency Generator A14 Schematic (Sheet 1 of 2)

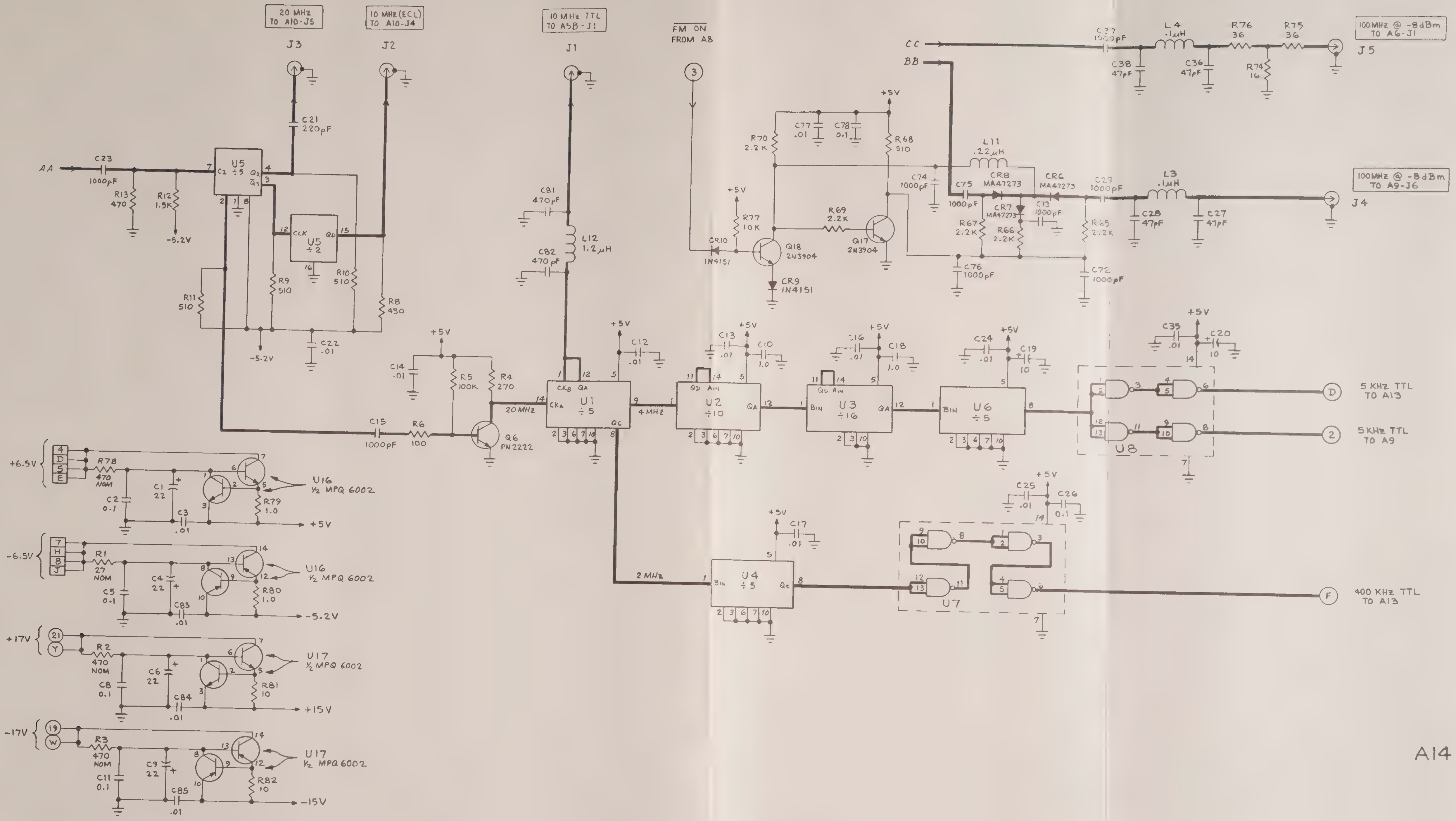

20 MHz TO A10-J5
10 MHz (ECL) TO A10-J4
10 MHz TTL TO A5B-J1
FM ON FROM A8
100MHz @ -8dBm TO A6-J1
100MHz @ -8dBm TO A9-J6
J3
J2
J1
J5
J4
AA
BB
CC
C23 1000pF
R13 470
R12 1.5K
-5.2V
U5 ÷5
U5 ÷2
C21 220pF
R9 510
R10 510
R11 510
R8 430
C22 .01
C81 470pF
C82 470pF
L12 1.2μH
C14 .01
R5 100K
R4 270
C15 1000pF
R6 100
Q6 PN2222
20 MHz
U1 ÷5
4 MHz
U2 ÷10
U3 ÷16
U6 ÷5
U4 ÷5
2 MHz
C12 .01
C13 .01
C10 1.0
C16 .01
C18 1.0
C24 .01
C19 10
C35 .01
C20 10
C17 .01
C25 .01
C26 0.1
U8
U7
5 KHz TTL TO A13
5 KHz TTL TO A9
400 KHz TTL TO A13
+5V
C77 .01
C78 0.1
R70 2.2K
R68 510
R77 10K
CR10 1N4151
Q18 2N3904
CR9 1N4151
R69 2.2K
Q17 2N3904
C74 1000pF
C75 1000pF
L11 .22μH
CR8 MA47273
CR6 MA47273
CR7 MA47273
C73 1000pF
R67 2.2K
R66 2.2K
R65 2.2K
C76 1000pF
C72 1000pF
C29 1000pF
L3 .1μH
C28 47pF
C27 47pF
C37 1000pF
L4 .1μH
R76 36
R75 36
C38 47pF
C36 47pF
R74 16
+6.5V
R78 470 NOM
C1 22
C2 0.1
C3 .01
R79 1.0
U16 ½ MPQ 6002
+5V
-6.5V
R1 27 NOM
C4 22
C5 0.1
C83 .01
R80 1.0
-5.2V
+17V
R2 470 NOM
C6 22
C8 0.1
C84 .01
R81 10
U17 ½ MPQ 6002
+15V
-17V
R3 470 NOM
C9 22
C11 0.1
C85 .01
R82 10
-15V
A14

Figure 5-49. Reference Frequency Generator A14 Schematic (Sheet 2 of 2)

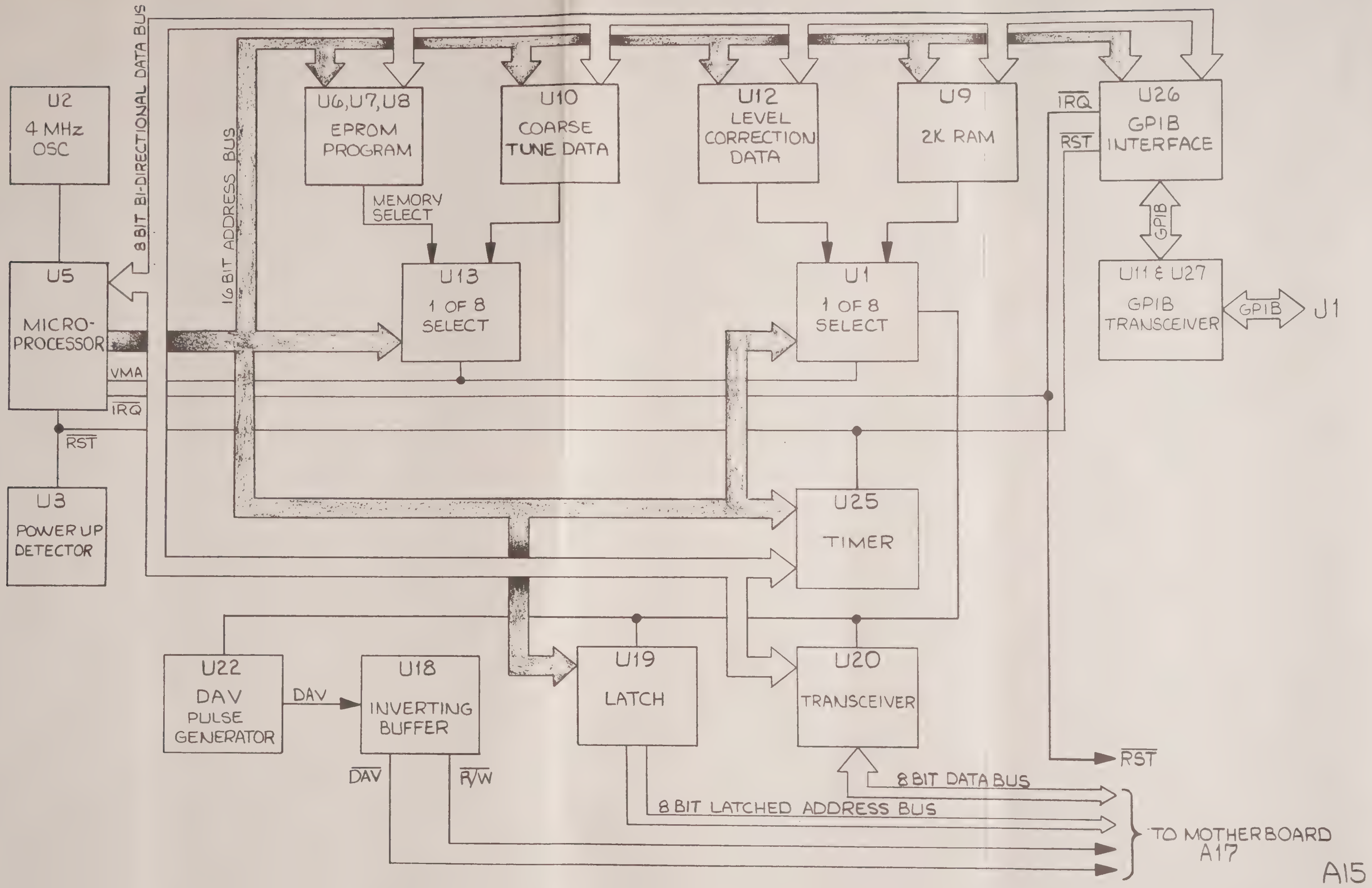
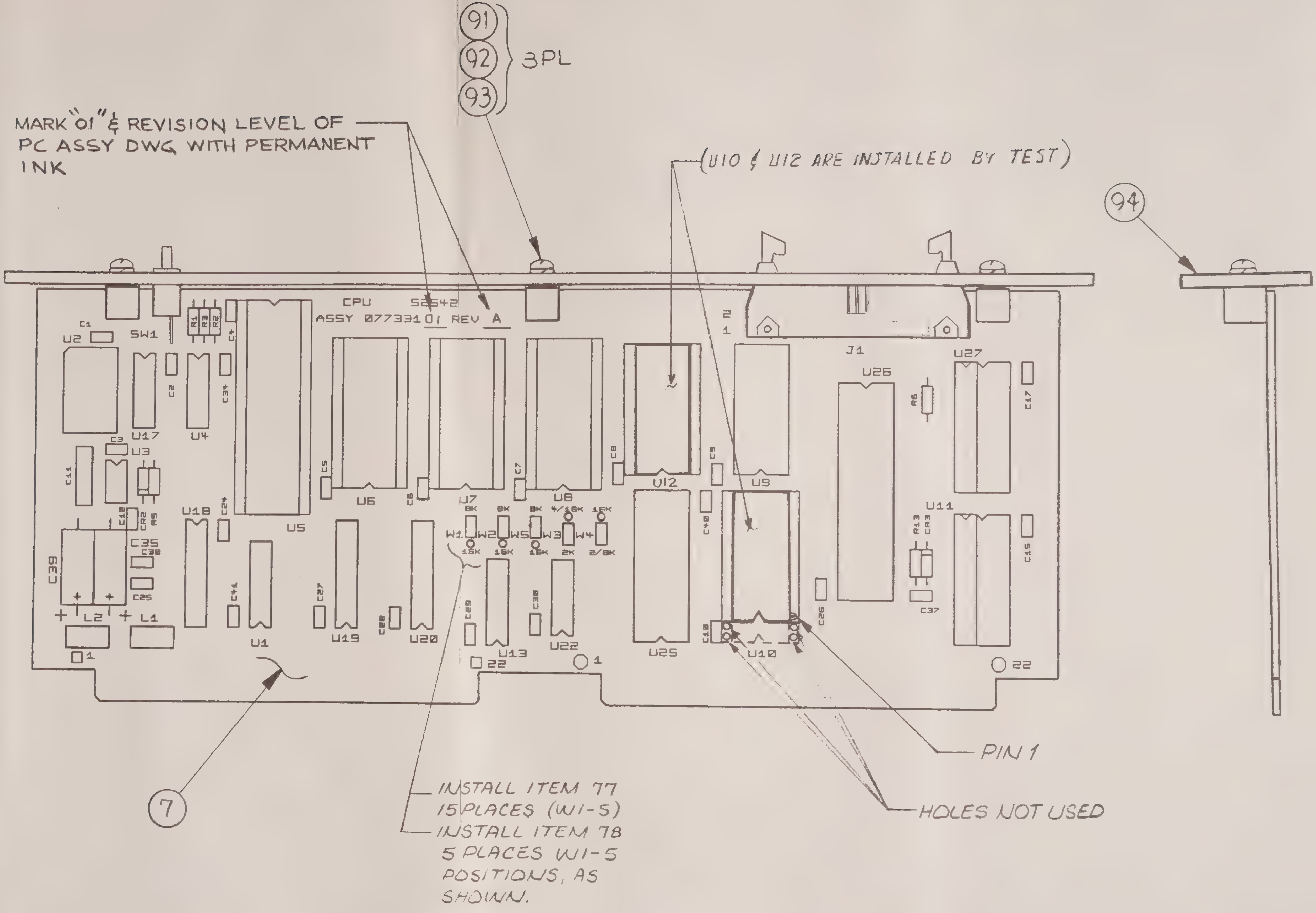
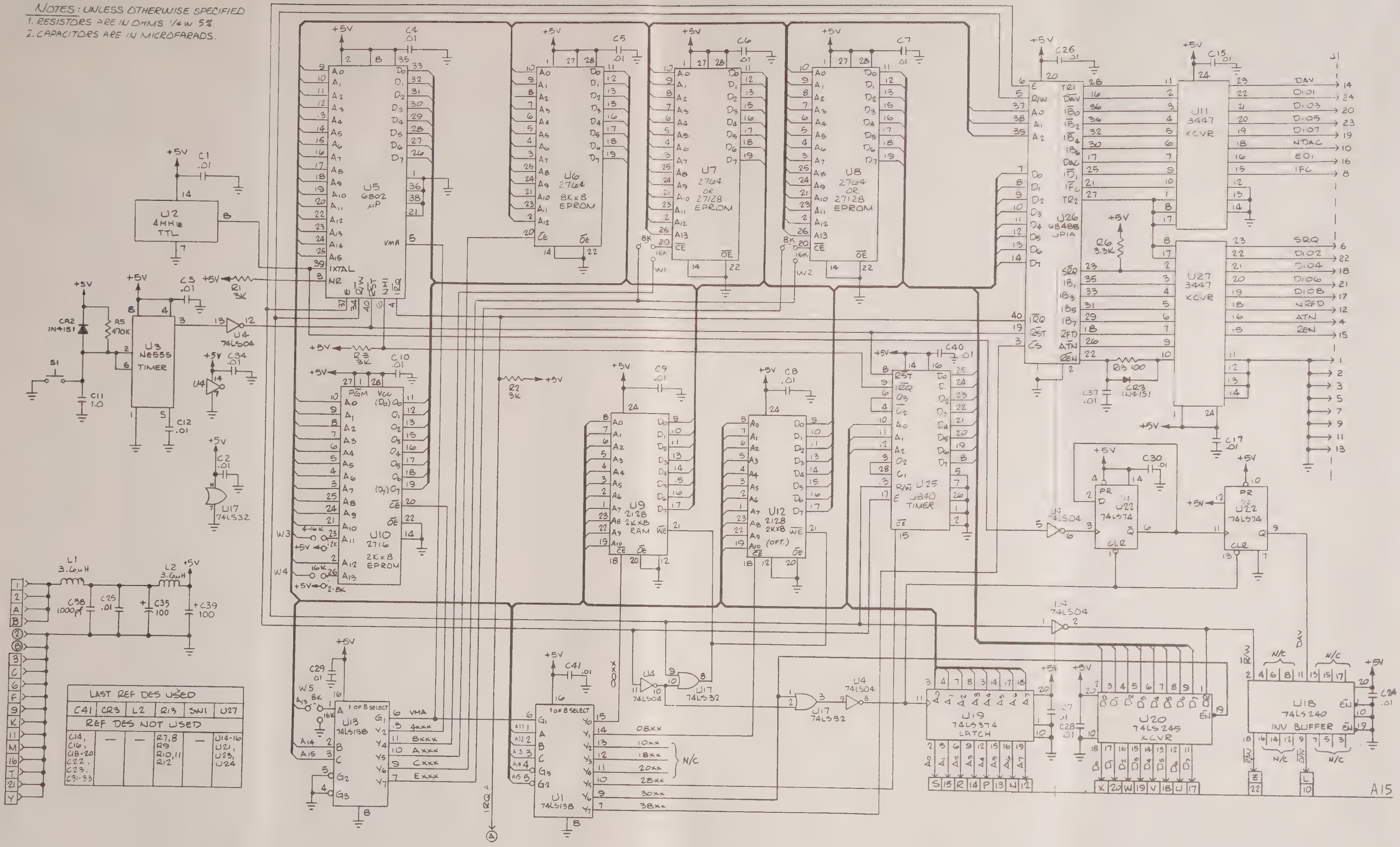

8 BIT BI-DIRECTIONAL DATA BUS
16 BIT ADDRESS BUS
U2
4 MHz
OSC
U5
MICRO-
PROCESSOR
VMA
IRQ
RST
U3
POWER UP
DETECTOR
U6,U7,U8
EPROM
PROGRAM
MEMORY
SELECT
U10
COARSE
TUNE DATA
U12
LEVEL
CORRECTION
DATA
U9
2K RAM
U26
GPIB
INTERFACE
IRQ
RST
GPIB
U11 & U27
GPIB
TRANSCEIVER
GPIB
J1
U13
1 OF 8
SELECT
U1
1 OF 8
SELECT
U25
TIMER
U22
DAV
PULSE
GENERATOR
DAV
U18
INVERTING
BUFFER
DAV
R/W
U19
LATCH
U20
TRANSCEIVER
RST
8 BIT DATA BUS
8 BIT LATCHED ADDRESS BUS
TO MOTHERBOARD
A17
A15

Figure 5-50. CPU A15 Block Diagram



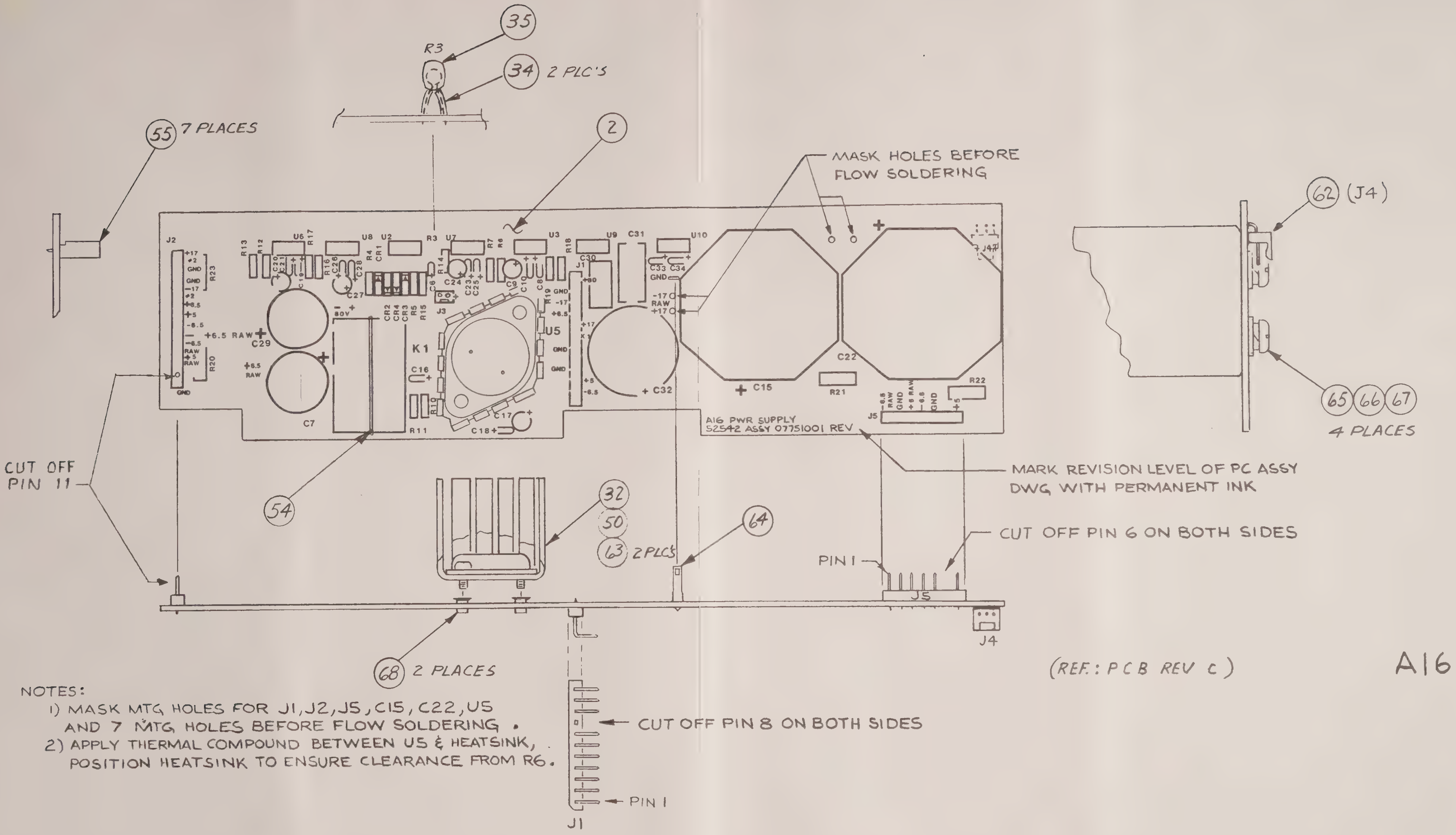
NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS 1/4W 5%.
2. CAPACITORS ARE IN MICROFARADS.



U5 6802 µP
U6 2764 8K×8 EPROM
U7 2764 OR 27128 EPROM
U8 2764 OR 27128 EPROM
U26 68488 GPIA
U11 3447 XCVR
U27 3447 XCVR
U2 4MHz TTL
U3 NE555 TIMER
U4 74LS04
U17 74LS32
U10 2716 2K×8 EPROM
U9 2128 2K×8 RAM
U12 2128 2K×8 (OPT.)
U25 6840 TIMER
U22 74LS74
U13 74LS138 1 OF 8 SELECT
U1 74LS138 1 OF 8 SELECT
U19 74LS374 LATCH
U20 74LS245 XCVR
U18 74LS240 INV BUFFER
CR2 1N4151
CR3 1N4151
R5 470K
R1 3K
R2 3K
R3 3K
R6 3.3K
R13 100
S1
C11 1.0
L1 3.6µH
L2 3.6µH
C38 1000pf
C25 .01
C35 100
C39 100
W1
W2
W3
W4
W5
VMA
4xxx
8xxx
Axxx
Cxxx
Exxx
08xx
10xx
18xx
20xx
28xx
30xx
38xx
N/C
IRQ
DAV
DIO1
DIO3
DIO5
DIO7
NDAC
EOI
IFC
SRQ
DIO2
DIO4
DIO6
DIO8
NRFD
ATN
REN
J1
A15
+5V

LAST REF DES USED					
C41	CR3	L2	R13	SW1	U27
REF DES NOT USED					
C14, C16, C18-20 C22. C23. C31-33	—	—	R7,8 R9 R10,11 R12	—	U14-16 U21, U23, U24

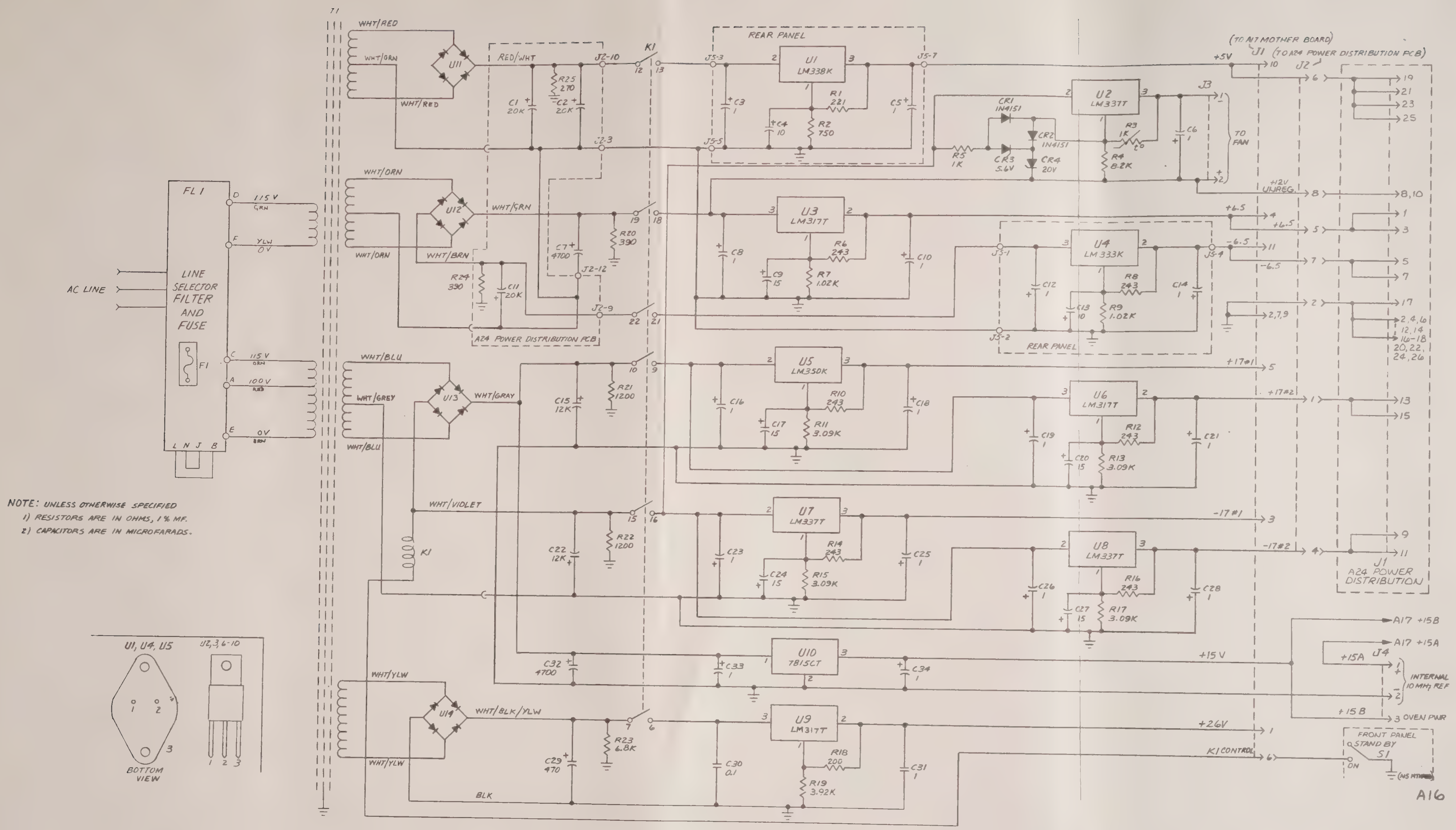
Figure 5-52. CPU A15 Schematic


35
R3
34 2 PLC'S
55 7 PLACES
2
MASK HOLES BEFORE FLOW SOLDERING
62 (J4)
J2
U6
R17
U8
U2
R3
U7
U3
U9
C31
U10
R13
R12
C20
C21
C19
R16
C26
C28
R4
CR1
R14
C24
C23
C25
C9
C10
C8
R18
J1
C30
C33
C34
GND
-17
RAW
+17
C27
80V
CR2
CR4
CR3
R5
R15
J3
R19
U5
K1
C16
C29
+6.5 RAW
C7
R11
R10
C17
C18
+ C32
+ C15
C21
C22
R21
R22
J5
J4
A16 PWR SUPPLY
52542 ASSY 07751001 REV
65 66 67
4 PLACES
MARK REVISION LEVEL OF PC ASSY DWG WITH PERMANENT INK
CUT OFF PIN 11
54
32
50
63 2 PLC'S
64
CUT OFF PIN 6 ON BOTH SIDES
PIN 1
J5
J4
68 2 PLACES
CUT OFF PIN 8 ON BOTH SIDES
PIN 1
J1
(REF.: PCB REV C)
A16

NOTES:

1) MASK MTG HOLES FOR J1, J2, J5, C15, C22, U5 AND 7 MTG HOLES BEFORE FLOW SOLDERING.
2) APPLY THERMAL COMPOUND BETWEEN U5 & HEATSINK, POSITION HEATSINK TO ENSURE CLEARANCE FROM R6.

Figure 5-53. Power Supply PC Board Assembly A16


T1
WHT/RED
WHT/ORN
WHT/RED
U11
RED/WHT
R25 270
C1 20K
C2 20K
J2-10
K1
12
13
J2-3
REAR PANEL
J5-3
U1 LM338K
2
3
J5-7
C3 1
R1 221
C4 10
R2 750
C5 1
J5-5
U2 LM337T
CR1 1N4151
CR2 1N4151
R3 1K
R4 8.2K
R5 1K
CR3 5.6V
CR4 20V
C6 1
J3
TO FAN
(TO A17 MOTHER BOARD)
J1 (TO A24 POWER DISTRIBUTION PCB)
J2
+5V
10
6
19
21
23
25
+12V UNREG.
8
8,10
WHT/ORN
U12
WHT/GRN
WHT/ORN
WHT/BRN
C7 4700
R20 390
19
18
J2-12
R24 390
C11 20K
J2-9
22
21
A24 POWER DISTRIBUTION PCB
U3 LM317T
R6 243
R7 1.02K
C8 1
C9 15
C10 1
+6.5
4
+6.5
5
1
3
U4 LM333K
J5-1
J5-4
C12 1
C13 10
R8 243
R9 1.02K
C14 1
J5-2
REAR PANEL
-6.5
11
-6.5
7
5
7
2
17
2,7,9
2,4,6
12,14
16-18
20,22,
24,26
FL1
D
115V GRN
F
YLW 0V
LINE SELECTOR FILTER AND FUSE
AC LINE
F1
C
115V ORN
A
100V RED
E
0V BRN
L N J B
WHT/BLU
WHT/GREY
WHT/BLU
U13
WHT/GRAY
C15 12K
R21 1200
10
9
U5 LM350K
R10 243
R11 3.09K
C16 1
C17 15
C18 1
+17#1
5
U6 LM317T
R12 243
R13 3.09K
C19 1
C20 15
C21 1
+17#2
1
13
15
WHT/VIOLET
K1
C22 12K
R22 1200
15
16
U7 LM337T
R14 243
R15 3.09K
C23 1
C24 15
C25 1
-17#1
3
U8 LM337T
R16 243
R17 3.09K
C26 1
C27 15
C28 1
-17#2
4
9
11
J1 A24 POWER DISTRIBUTION
C32 4700
U10 7815CT
C33 1
C34 1
+15V
A17 +15B
A17 +15A
+15A
J4
INTERNAL 10 MHz REF
+15B
3 OVEN PWR
WHT/YLW
U14
WHT/BLK/YLW
WHT/YLW
C29 470
R23 6.8K
7
6
U9 LM317T
C30 0.1
R18 200
R19 3.92K
C31 1
+26V
1
K1 CONTROL
6
FRONT PANEL STAND BY S1
ON
BLK
U1, U4, U5
U2,3,6-10
1
2
3
BOTTOM VIEW
1 2 3
A16

NOTE: UNLESS OTHERWISE SPECIFIED
1) RESISTORS ARE IN OHMS, 1% MF.
2) CAPACITORS ARE IN MICROFARADS.

Figure 5-54. Power Supply A16 Schematic

]

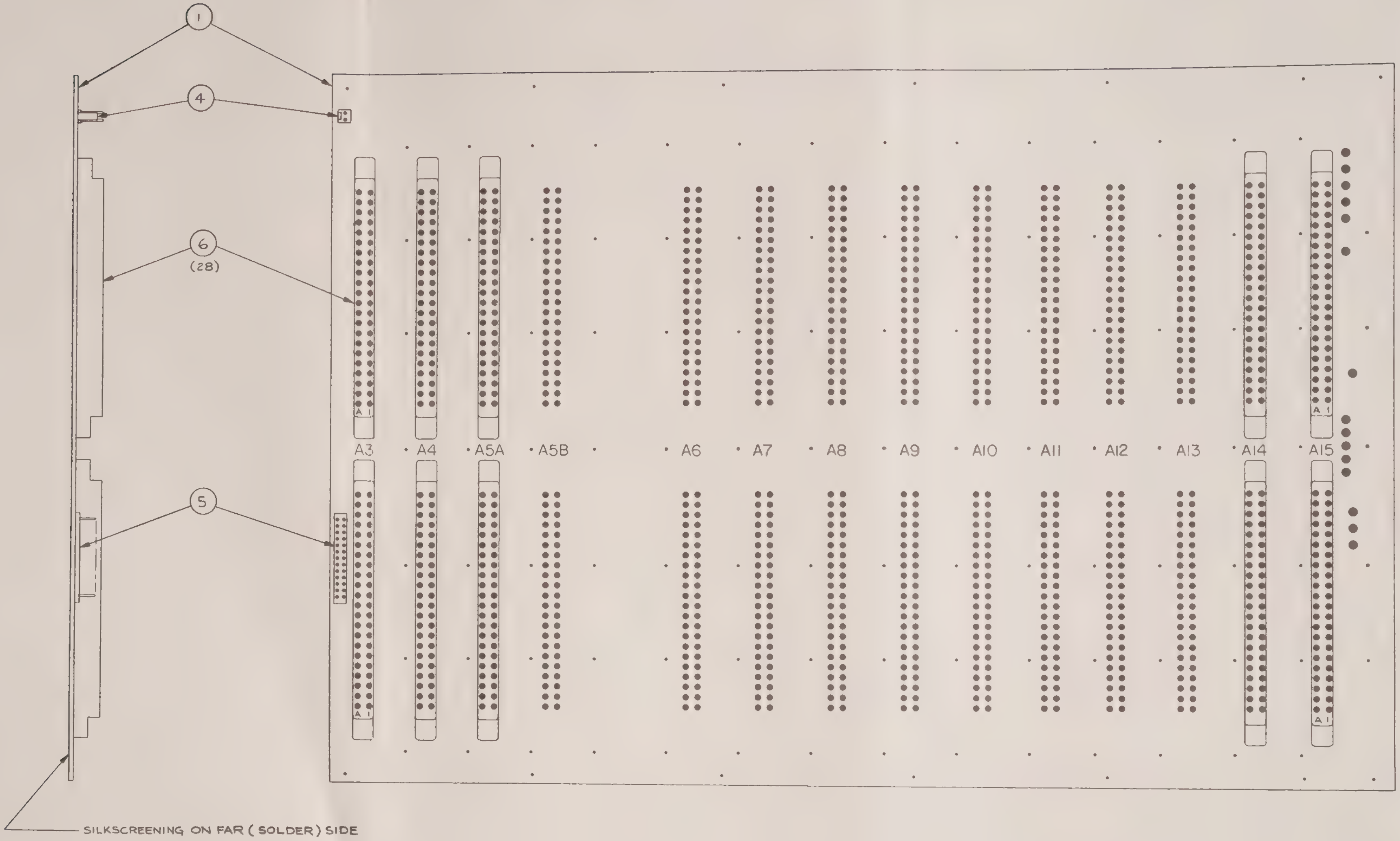

1
4
6
(28)
5
A3
A4
A5A
A5B
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
A1
SILKSCREENING ON FAR (SOLDER) SIDE

Figure 5-55. Motherboard PC Board Assembly A17

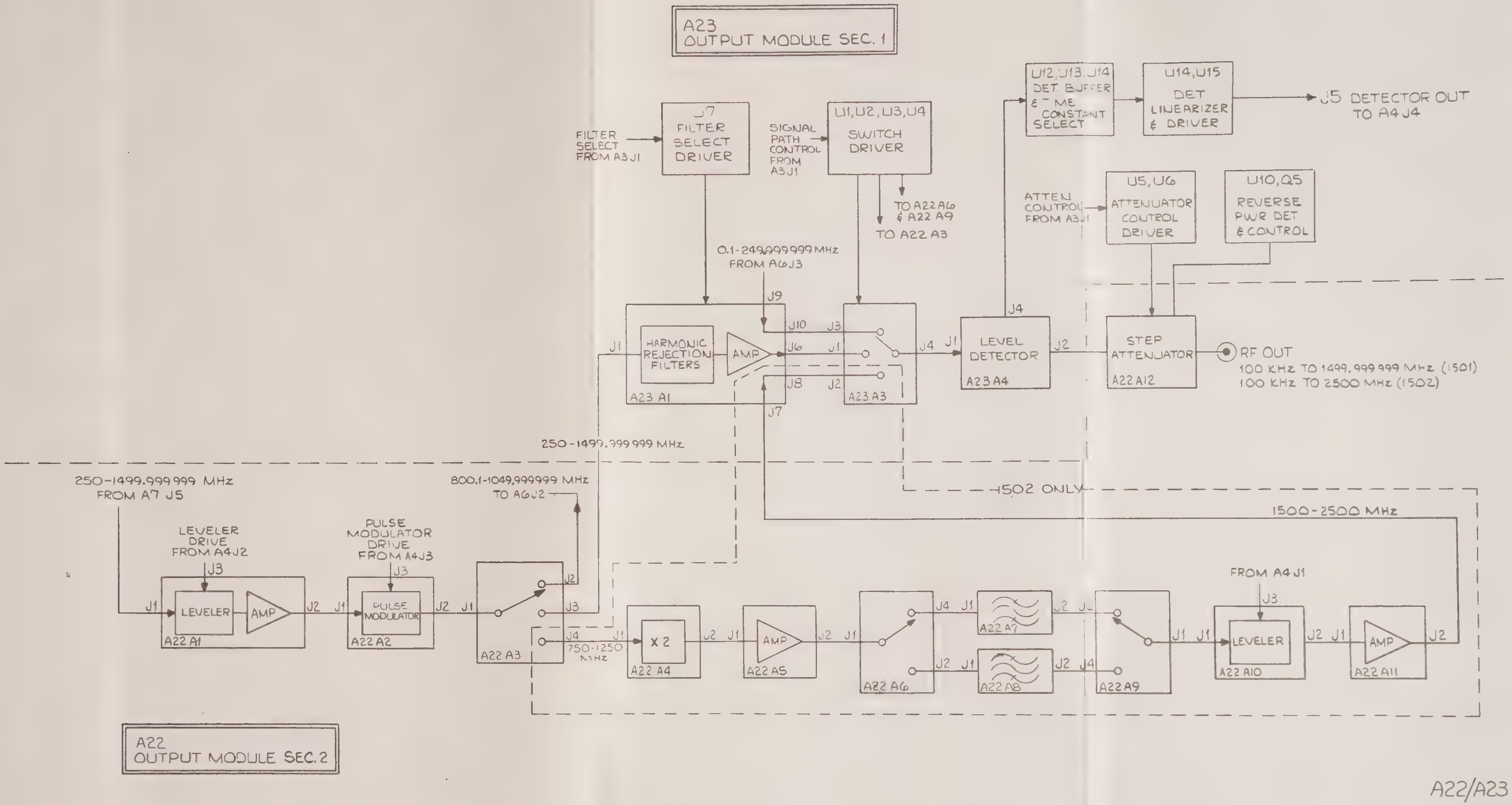

A23
OUTPUT MODULE SEC. 1
FILTER SELECT FROM A3 J1
J7
FILTER SELECT DRIVER
SIGNAL PATH CONTROL FROM A3 J1
U1, U2, U3, U4
SWITCH DRIVER
TO A22 A6 & A22 A9
TO A22 A3
U12, U13, U14
DET. BUFFER & TIME CONSTANT SELECT
U14, U15
DET LINEARIZER & DRIVER
J5 DETECTOR OUT TO A4 J4
ATTEN CONTROL FROM A3 J1
U5, U6
ATTENUATOR CONTROL DRIVER
U10, Q5
REVERSE PWR DET & CONTROL
0.1-249.999999 MHz FROM A6 J3
J9
J1
HARMONIC REJECTION FILTERS
AMP
J10
J6
J8
J7
A23 A1
J3
J1
J2
J4
A23 A3
J1
LEVEL DETECTOR
J4
J2
A23 A4
STEP ATTENUATOR
A22 A12
RF OUT
100 KHz TO 1499.999 999 MHz (1501)
100 KHz TO 2500 MHz (1502)
250-1499.999 999 MHz
1502 ONLY
1500-2500 MHz
250-1499.999 999 MHz FROM A7 J5
LEVELER DRIVE FROM A4 J2
J3
J1
LEVELER
AMP
J2
A22 A1
PULSE MODULATOR DRIVE FROM A4 J3
J3
J1
PULSE MODULATOR
J2
A22 A2
800.1-1049.999999 MHz TO A6 J2
J1
J2
J3
J4
A22 A3
750-1250 MHz
J1
X 2
J2
A22 A4
J1
AMP
J2
A22 A5
J1
J4
J2
A22 A6
J1
J2
A22 A7
J1
J2
A22 A8
J4
A22 A9
J1
FROM A4 J1
J3
J1
LEVELER
J2
A22 A10
J1
AMP
J2
A22 A11
A22
OUTPUT MODULE SEC. 2
A22/A23

Figure 5-56. Output Module A22/A23 Block Diagram

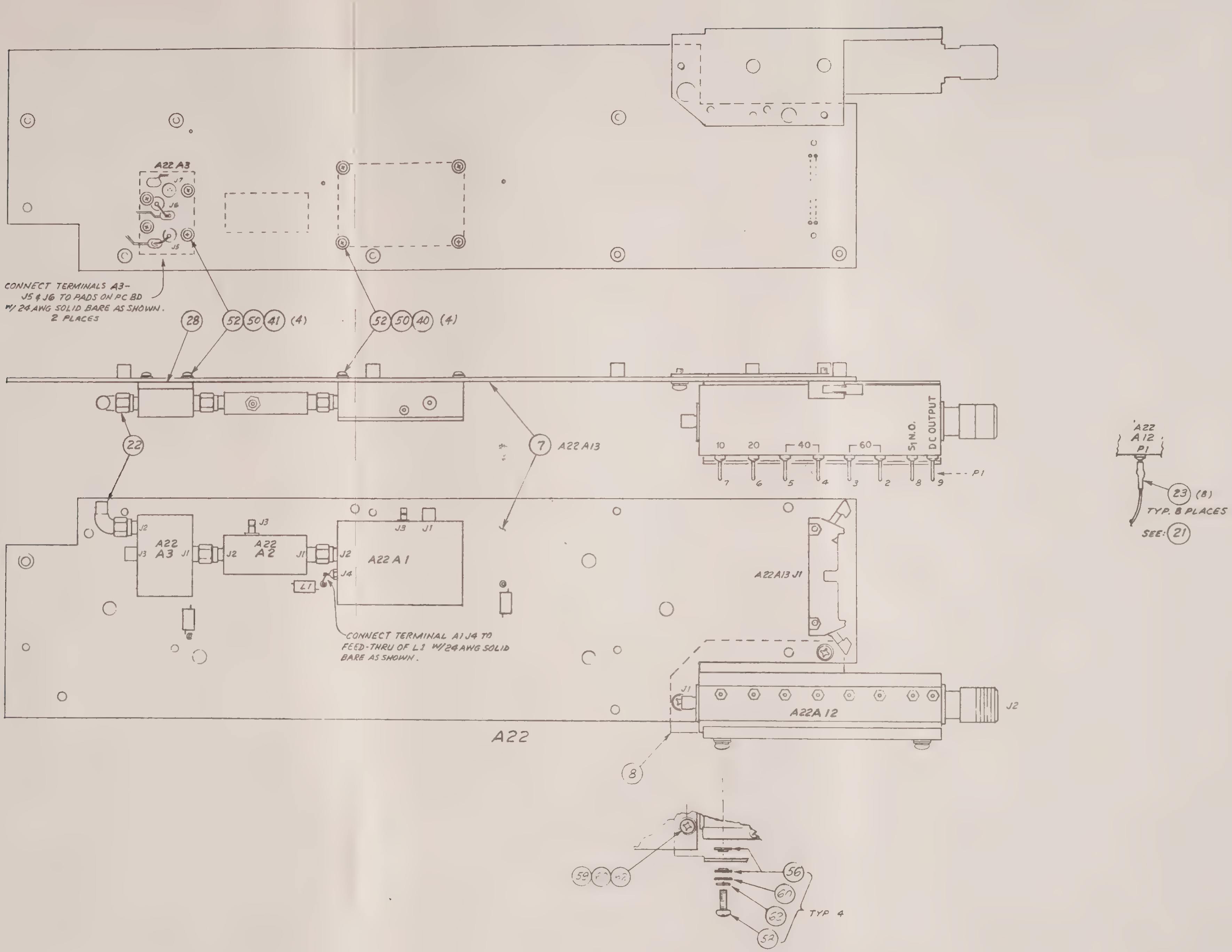
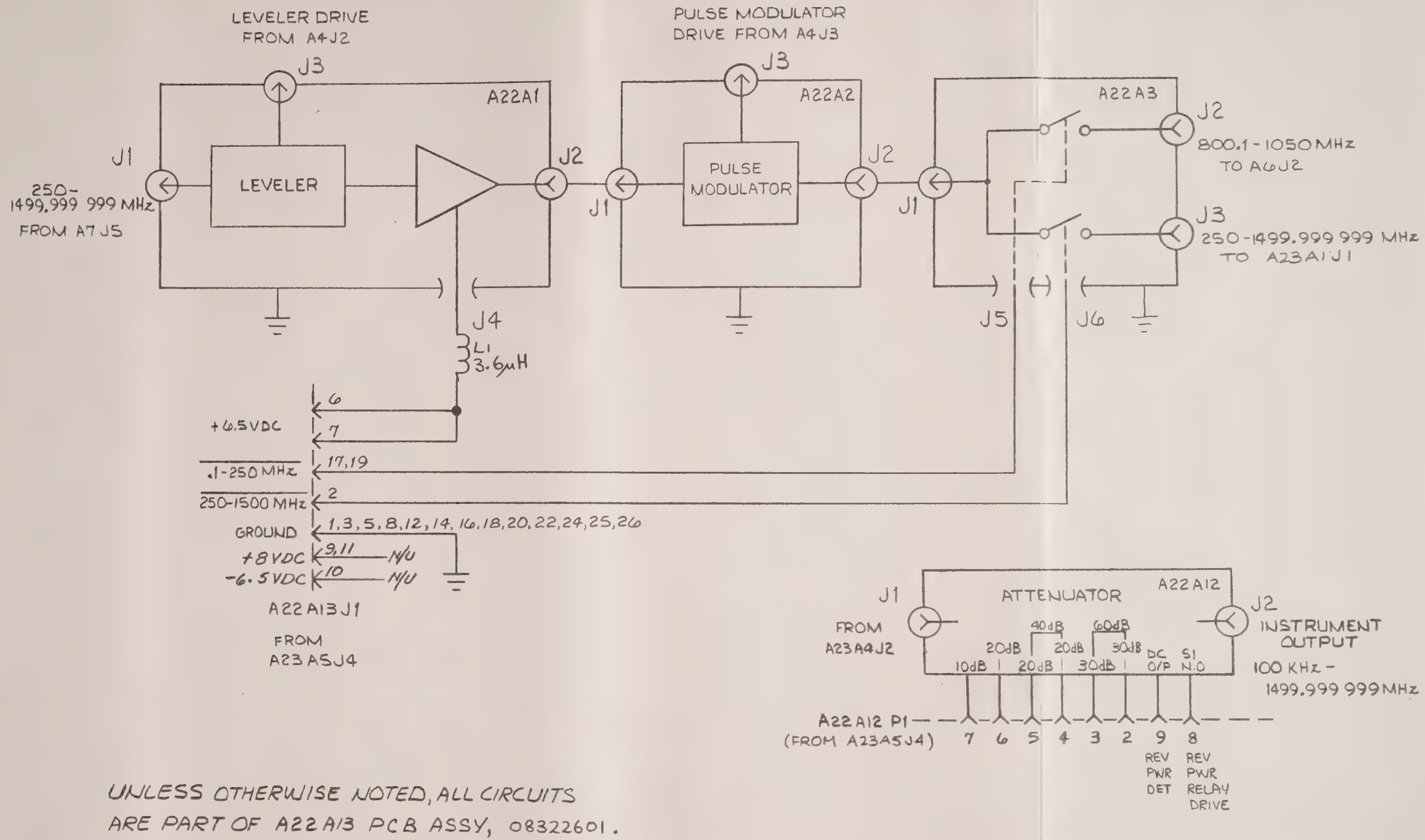
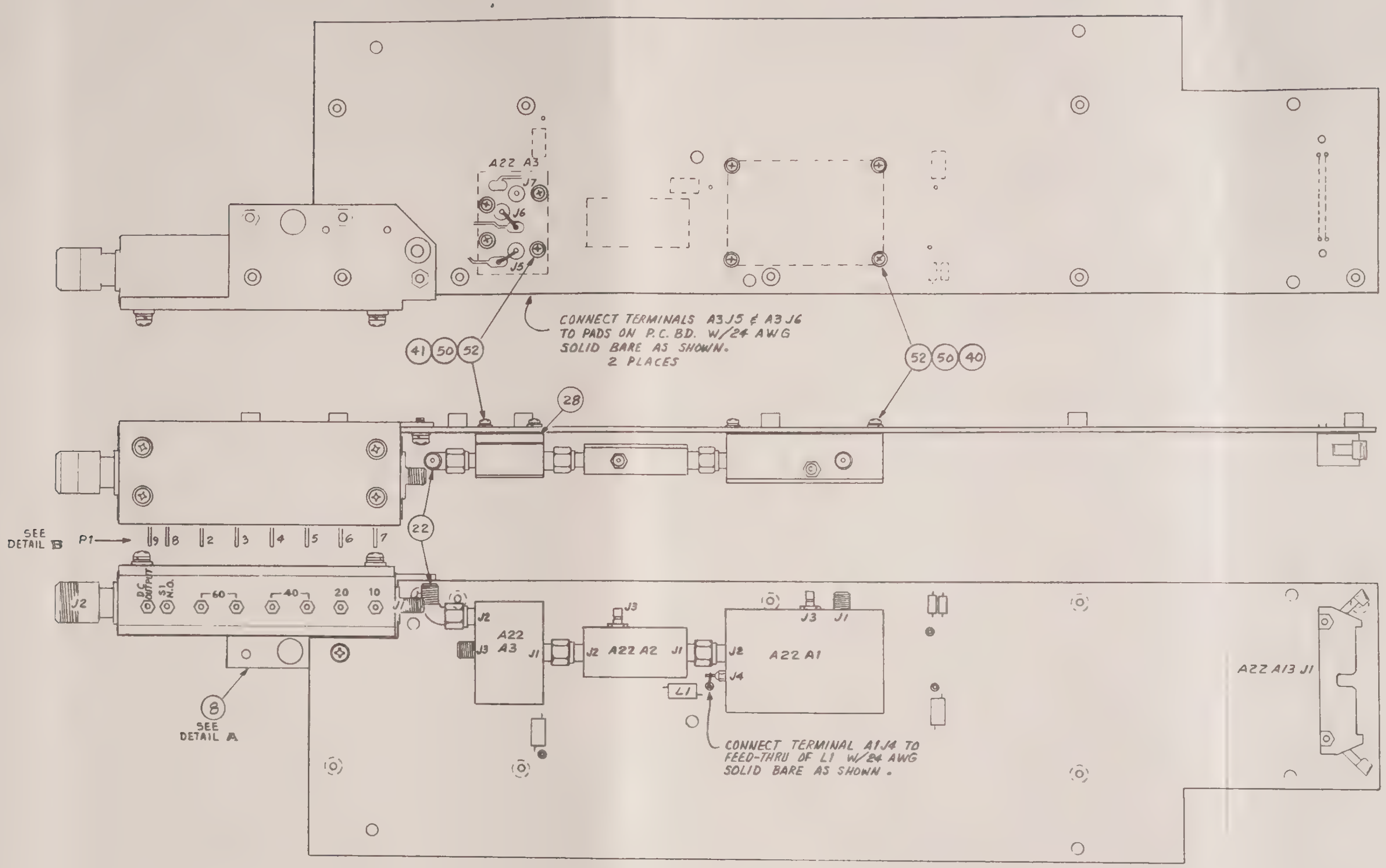

A22 A3
J7
J6
J5
CONNECT TERMINALS A3-J5 & J6 TO PADS ON PC BD W/ 24 AWG SOLID BARE AS SHOWN. 2 PLACES
28
52 50 41 (4)
52 50 40 (4)
22
7 A22A13
10 20 40 60
S1 N.O.
DC OUTPUT
7 6 5 4 3 2 8 9
P1
A22 A12 P1
23 (8)
TYP. 8 PLACES
SEE: 21
J2
A22 A3
J3 J1
J3
A22 A2
J2 J1
J3 J1
J2
A22 A1
J4
L1
A22A13 J1
CONNECT TERMINAL A1 J4 TO FEED-THRU OF L1 W/24 AWG SOLID BARE AS SHOWN.
J1
A22A12
J2
A22
8
56
60
63
52
TYP 4

Figure 5-57. Model 1501 Output Module Section 2 Assembly A22


LEVELER DRIVE FROM A4J2
J3
A22A1
J1
250-1499.999 999 MHz FROM A7J5
LEVELER
J2
J4
L1 3.6μH
PULSE MODULATOR DRIVE FROM A4J3
J3
A22A2
J1
PULSE MODULATOR
J2
A22A3
J1
J2
800.1-1050MHz TO A6J2
J3
250-1499.999 999 MHz TO A23A1J1
J5
J6
6
+6.5VDC
7
17,19
.1-250 MHz
2
250-1500 MHz
GROUND
1,3,5,8,12,14,16,18,20,22,24,25,26
+8VDC
9,11
N/U
-6.5VDC
10
N/U
A22A13J1
FROM A23A5J4
ATTENUATOR
A22A12
J1
FROM A23A4J2
J2
INSTRUMENT OUTPUT
100 KHz - 1499.999 999MHz
40dB
60dB
20dB
20dB
30dB
10dB
20dB
30dB
DC O/P
S1 N.O
A22A12 P1 (FROM A23A5J4)
7
6
5
4
3
2
9
8
REV PWR DET
REV PWR RELAY DRIVE

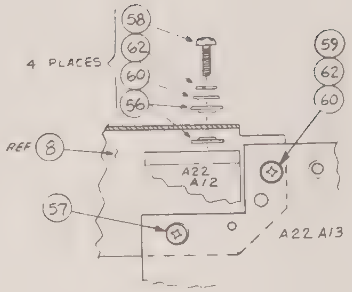
UNLESS OTHERWISE NOTED, ALL CIRCUITS ARE PART OF A22A13 PCB ASSY, 08322601.

Figure 5-58. Model 1501 Output Module Section 2 A22 Schematic

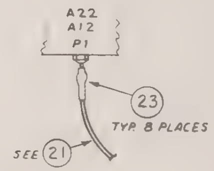

A22 A3
J7
J6
J5
41 50 52
52 50 40
28
22
SEE DETAIL B
P1
9
8
2
3
4
5
6
7
J2
D.C. OUTPUT
S1 N.O.
60
40
20
10
J1
J2
A22 A3
J3
J1
J3
J2
A22 A2
J1
J3
J1
J2
A22 A1
J4
L1
A22 A13 J1
8
SEE DETAIL A

CONNECT TERMINALS A3J5 & A3J6 TO PADS ON P.C. BD. W/24 AWG SOLID BARE AS SHOWN.
2 PLACES

CONNECT TERMINAL A1J4 TO FEED-THRU OF L1 W/24 AWG SOLID BARE AS SHOWN.


58
62
60
56
4 PLACES
59
62
60
REF 8
A22 A12
57
A22 A13

DETAIL A


A22 A12 P1
23
TYP. 8 PLACES
SEE 21

DETAIL B

Figure 5-59. Model 1501 Output Module Section 2 Rear Panel Assembly A22 (Option 02)

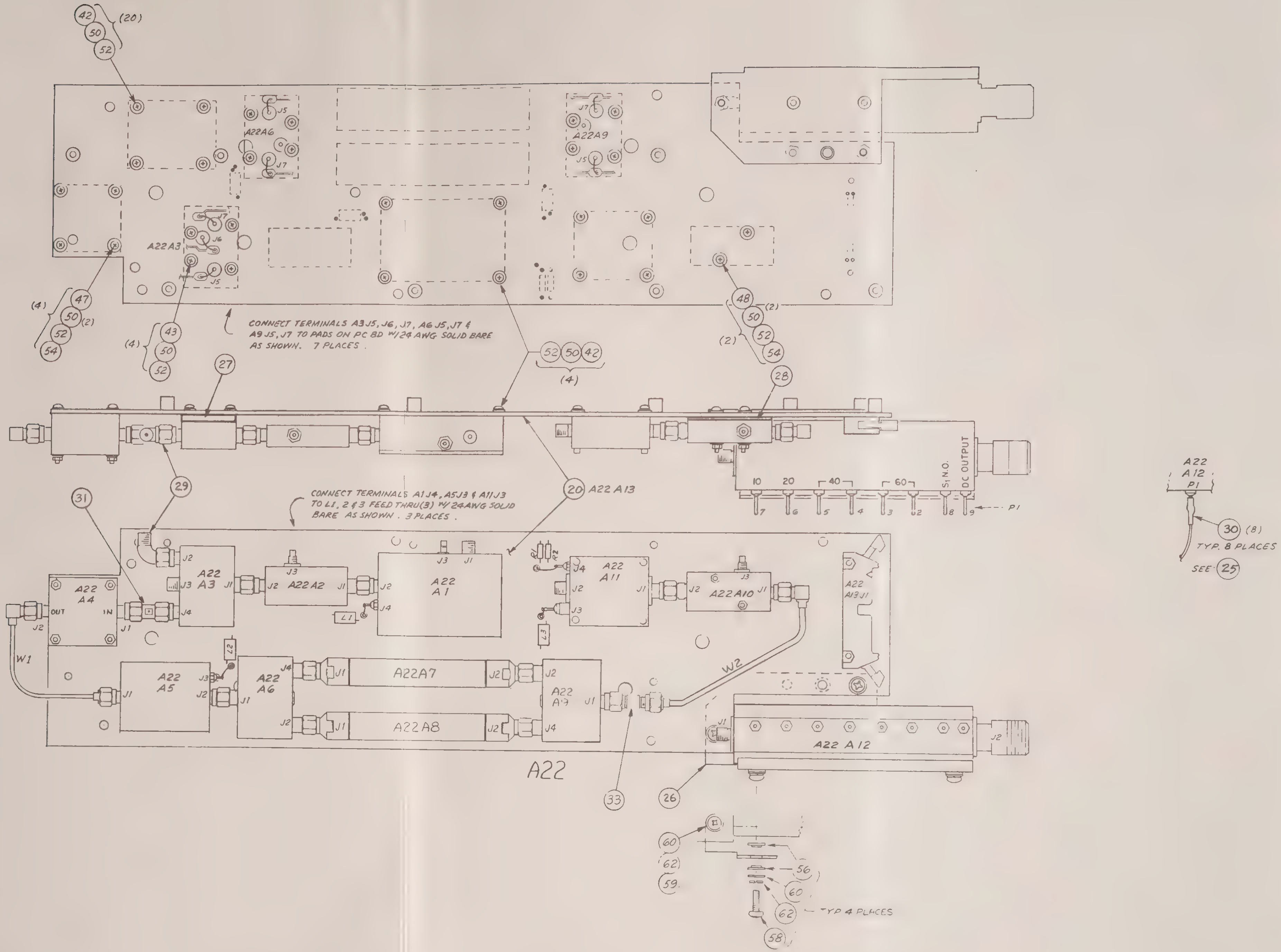
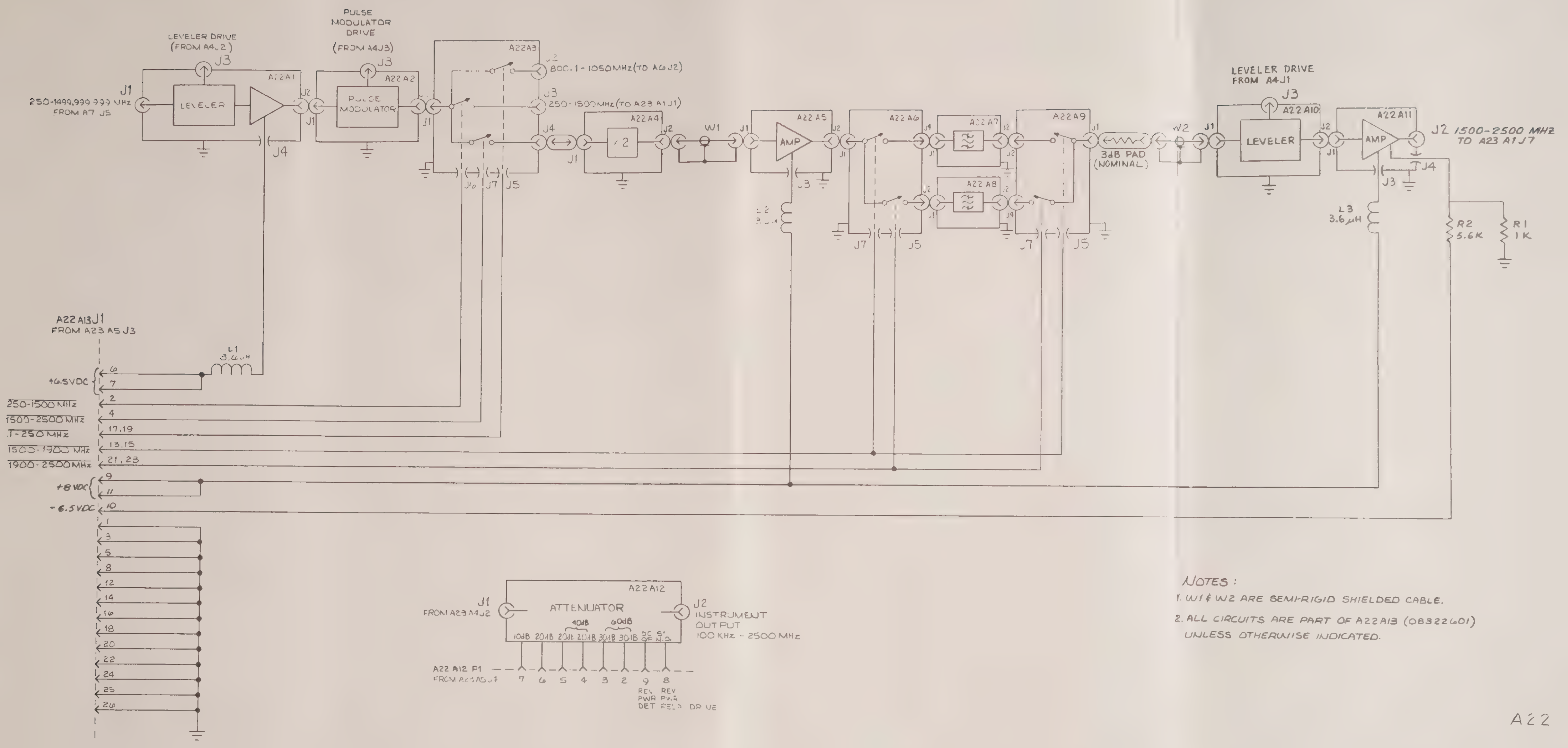

42
50
52
(20)
A22A6
J5
J7
A22A9
J7
J5
A22A3
J7
J6
J5
(4)
47
50 (2)
52
54
(4)
43
50
52
CONNECT TERMINALS A3 J5, J6, J7, A6 J5, J7 & A9 J5, J7 TO PADS ON PC BD W/24 AWG SOLID BARE AS SHOWN. 7 PLACES.
52 50 42
(4)
48 (2)
50
52
54
(2)
27
28
DC OUTPUT
S1 N.O.
10
20
40
60
7 6 5 4 3 2 8 9
P1
29
31
CONNECT TERMINALS A1 J4, A5 J3 & A11 J3 TO L1, 2 & 3 FEED THRU(3) W/24AWG SOLID BARE AS SHOWN. 3 PLACES.
20 A22 A13
A22 A4
OUT
IN
J1
J2
W1
A22 A3
J1 J2 J3 J4
A22 A2
J1 J2 J3
A22 A1
J1 J2 J3 J4
L1
A22 A11
J1 J2 J3 J4
L3
A22 A10
J1 J2 J3
A22 A13 J1
W2
L2
A22 A5
J1 J2 J3
A22 A6
J1 J2 J4
A22A7
J1 J2
A22A8
J1 J2
A22 A9
J1 J2 J4
A22 A12
J1 J2
A22
33
26
60
62
59
56
60
62
TYP 4 PLACES
58
A22
A12
P1
30 (8)
TYP. 8 PLACES
SEE 25

Figure 5-60. Model 1502 Output Module Section 2 Assembly A22

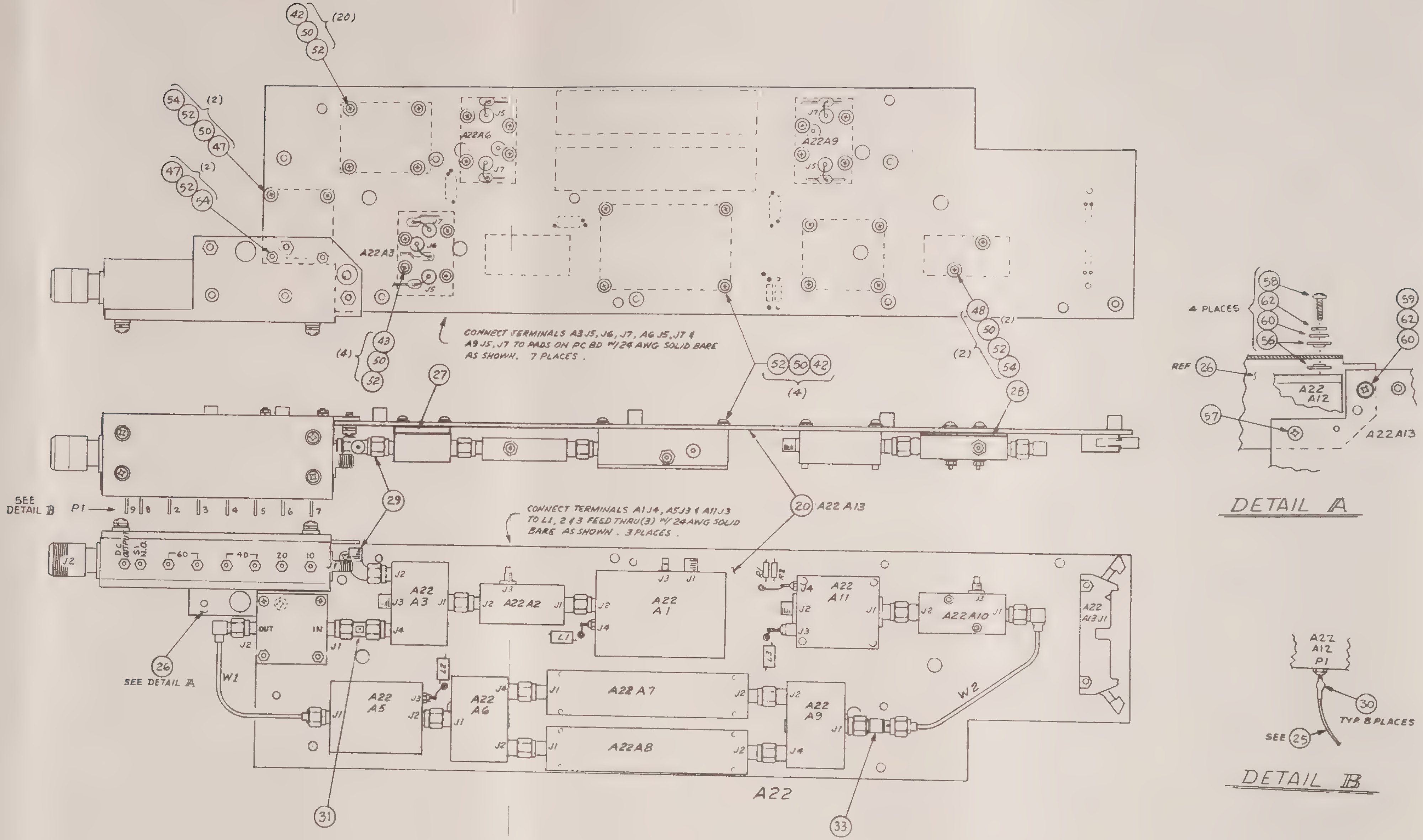


LEVELER DRIVE
(FROM A4J2)
J3
PULSE
MODULATOR
DRIVE
(FROM A4J3)
J3
A22A1
A22A2
A22A3
J1
250-1499.999 999 MHz
FROM A7 J5
LEVELER
J2
J1
PULSE
MODULATOR
J4
J1
J2
800.1-1050MHz(TO A6J2)
J3
250-1500MHz(TO A23 A1J1)
J4
J1
J6
J7
J5
A22A4
÷2
J2
W1
J1
A22A5
AMP
J2
J1
J3
L2
A22A6
J4
J2
J7
J5
A22A7
J1
J2
A22A8
J1
J2
J4
A22A9
J1
J7
J5
3dB PAD
(NOMINAL)
W2
LEVELER DRIVE
FROM A4J1
J3
A22A10
J1
LEVELER
J2
A22A11
J1
AMP
J2 1500-2500 MHZ
TO A23 A1J7
J4
J3
L3
3.6μH
R2
5.6K
R1
1K
A22A13J1
FROM A23 A5 J3
L1
3.6μH
+6.5VDC
6
7
$\overline{250\text{-}1500\ \text{MHz}}$
2
$\overline{1500\text{-}2500\ \text{MHz}}$
4
$\overline{.1\text{-}250\ \text{MHz}}$
17,19
$\overline{1500\text{-}1900\ \text{MHz}}$
13,15
$\overline{1900\text{-}2500\ \text{MHz}}$
21,23
+8VDC
9
11
-6.5VDC
10
1
3
5
8
12
14
16
18
20
22
24
25
26
A22A12
J1
FROM A23 A4J2
ATTENUATOR
40dB
60dB
10dB
20dB
20dB
20dB
30dB
30dB
DC OP
S' N.D.
J2
INSTRUMENT
OUTPUT
100 KHz - 2500 MHz
A22 A12 P1
FROM A23 A5 J7
7
6
5
4
3
2
9
8
REV
PWR
DET
REV
PWR
FELD
DRIVE
A22

NOTES:

1. W1 & W2 ARE SEMI-RIGID SHIELDED CABLE.
2. ALL CIRCUITS ARE PART OF A22A13 (08322601) UNLESS OTHERWISE INDICATED.

Figure 5-61. Model 1502 Output Module Section 2 A22 Schematic

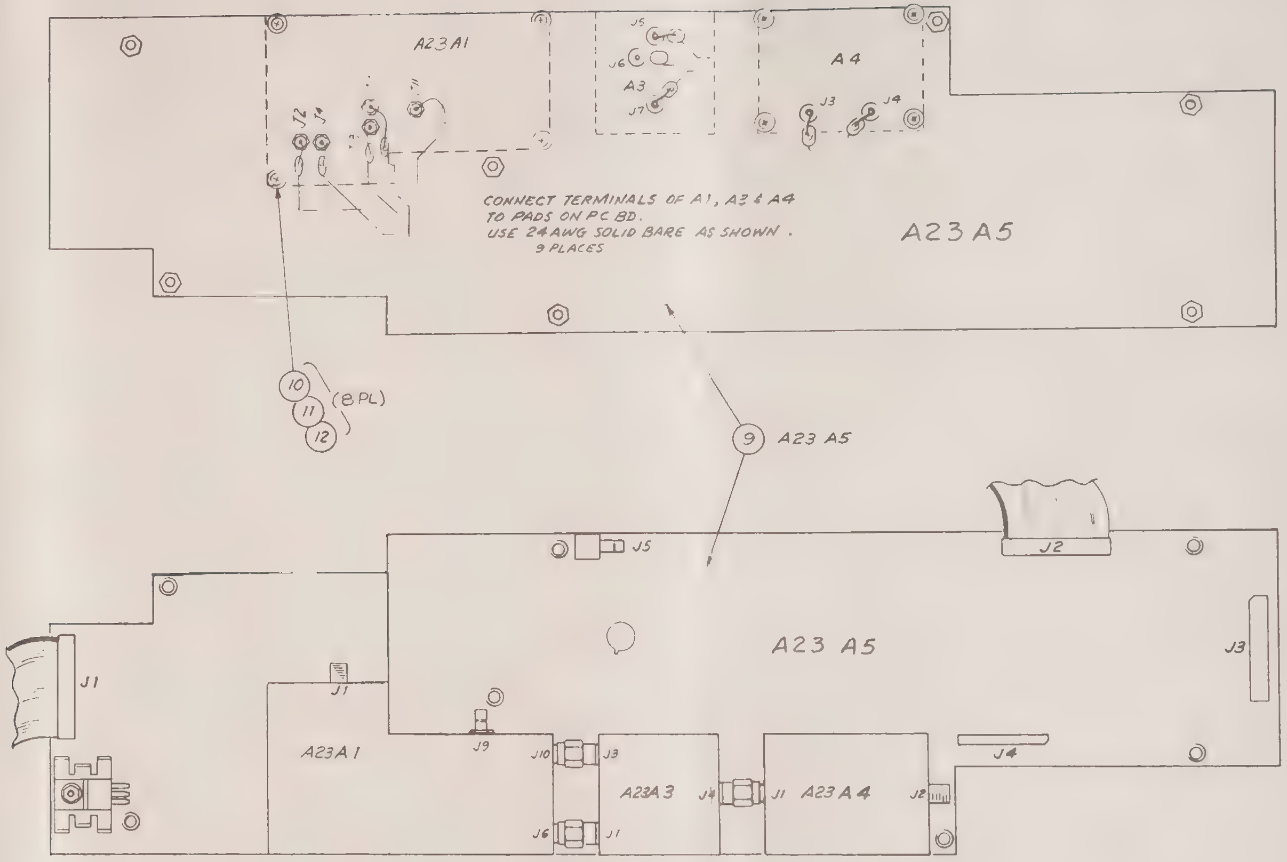


CONNECT TERMINALS A3 J5, J6, J7, A6 J5, J7 & A9 J5, J7 TO PADS ON PC BD W/24 AWG SOLID BARE AS SHOWN. 7 PLACES.

CONNECT TERMINALS A1 J4, A5 J3 & A11 J3 TO L1, 2 & 3 FEED THRU(3) W/ 24 AWG SOLID BARE AS SHOWN. 3 PLACES.

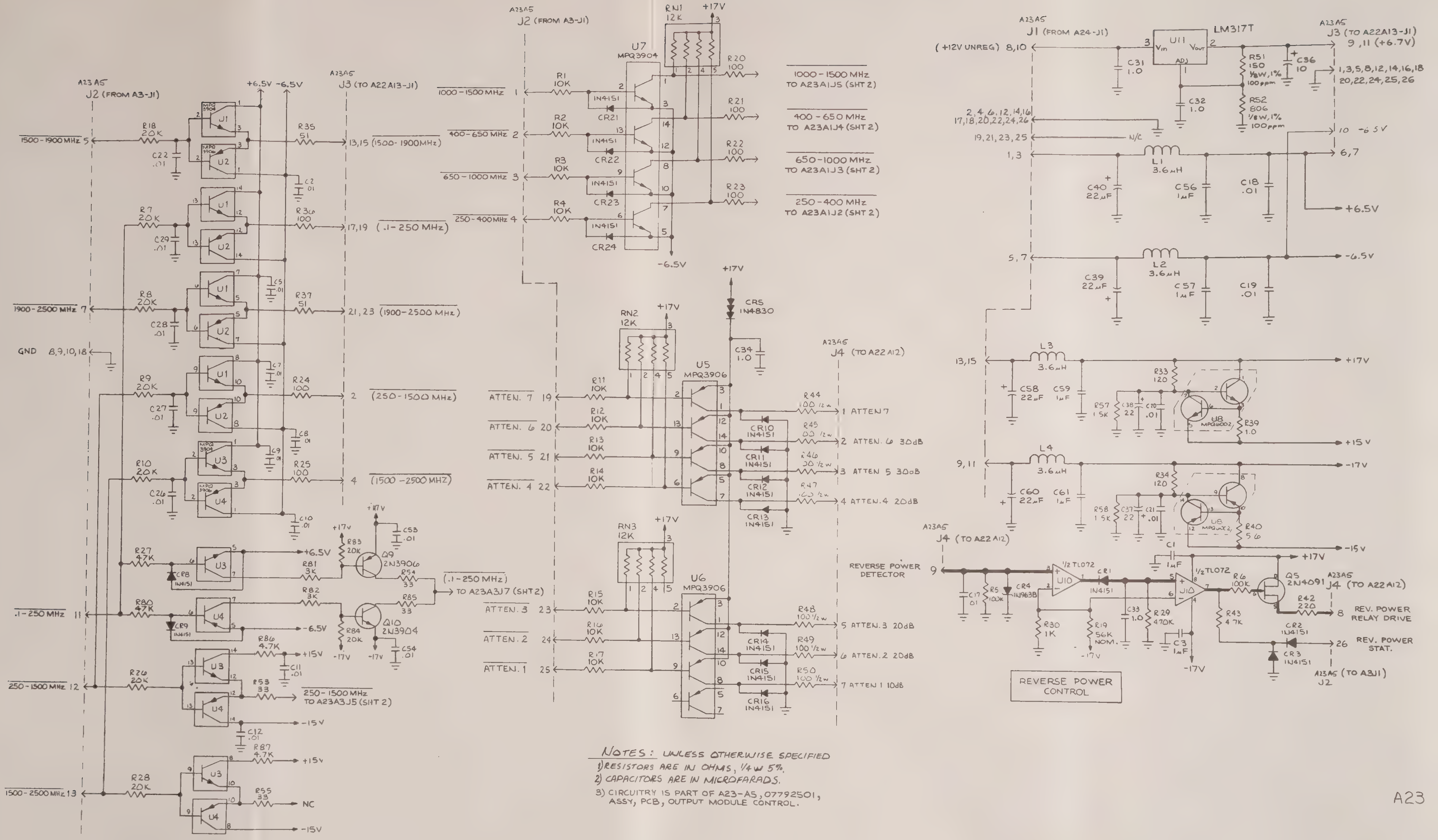
42
50
52
(20)
54
52
50
47
(2)
47
52
54
(2)
A22A6
J5
J7
A22A9
J7
J5
A22A3
J7
J6
J5
(4)
43
50
52
48
50
52
54
(2)
(2)
52
50
42
(4)
27
28
29
20
A22 A13
SEE DETAIL B
P1
9
8
2
3
4
5
6
7
D.C. OUTPUT
S1 N.O.
60
40
20
10
J2
J1
OUT
IN
J2
J1
26
SEE DETAIL A
W1
A22 A3
J2
J3
J4
J1
J3
A22 A2
J2
J1
A22 A1
J3
J1
J2
J4
L1
R1
R2
A22 A11
J4
J2
J3
J1
L3
A22 A10
J3
J2
J1
A22 A13 J1
L2
A22 A5
J1
J3
J2
A22 A6
J4
J1
J2
A22 A7
J1
J2
A22 A8
J1
J2
A22 A9
J2
J1
J4
W2
A22
31
33
4 PLACES
58
62
60
56
59
62
60
REF
26
A22 A12
57
A22 A13
DETAIL A
A22 A12 P1
30
TYP 8 PLACES
SEE 25
DETAIL B

Figure 5-62. Model 1502 Output Module Section 2 Rear Panel Assembly A22 (Option 02)


A23A1
J2
J4
J5
J6
A3
J7
A4
J3
J4
A23 A5
10
11
12
(8 PL)
9
A23 A5
J5
J2
J1
J1
A23 A5
J3
J9
A23A 1
J10
J3
J6
J1
A23A 3
J4
J1
A23 A 4
J2
J4

CONNECT TERMINALS OF A1, A3 & A4
TO PADS ON PC BD.
USE 24AWG SOLID BARE AS SHOWN.
9 PLACES

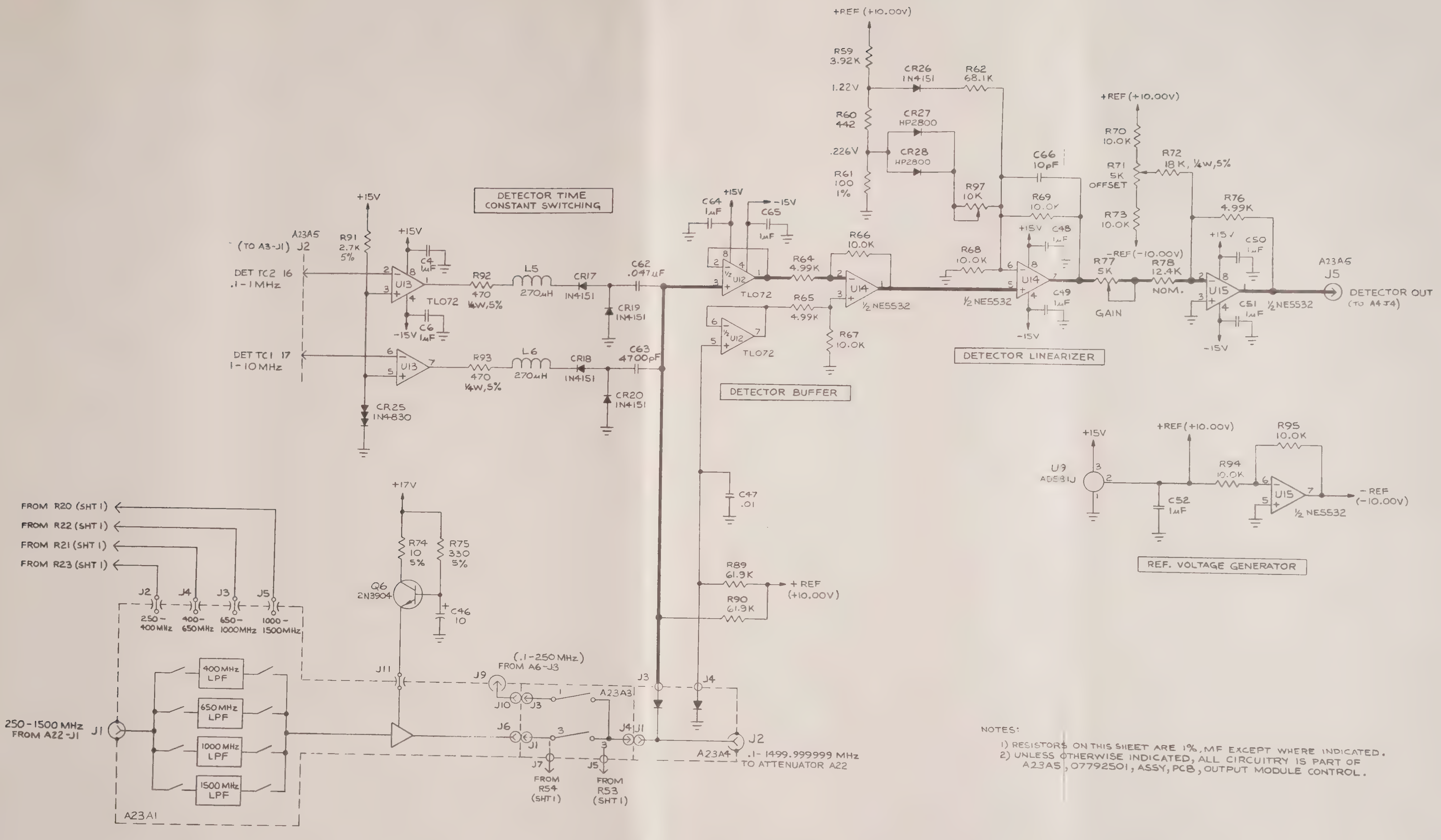
Figure 5-63. Model 1501 Output Module Section 1 Assembly A23


A23A5 J2 (FROM A3-J1)
1500-1900 MHz 5
1900-2500 MHz 7
GND 8,9,10,18
.1-250 MHz 11
250-1500 MHz 12
1500-2500 MHz 13
R18 20K
R7 20K
R8 20K
R9 20K
R10 20K
R27 4.7K
R80 4.7K
R26 20K
R28 20K
C22 .01
C29 .01
C28 .01
C27 .01
C26 .01
CR8 1N4151
CR9 1N4151
MPQ3904
MPQ3906
J1
U1
U2
U3
U4
+6.5V -6.5V
A23A5 J3 (TO A22A13-J1)
R35 51
13,15 (1500-1900 MHz)
R36 100
17,19 (.1-250 MHz)
R37 51
21,23 (1900-2500 MHz)
R24 100
2 (250-1500 MHz)
R25 100
4 (1500-2500 MHz)
+6.5V
-6.5V
R81 3K
R82 3K
R83 20K
R84 20K
Q9 2N3906
Q10 2N3904
R54 33
R85 33
C53 .01
C54 .01
(.1-250 MHz) TO A23A3J7 (SHT 2)
R86 4.7K
+15V
C11 .01
R53 33
250-1500 MHz TO A23A3J5 (SHT 2)
-15V
C12 .01
R87 4.7K
R55 33
NC
A23A5 J2 (FROM A3-J1)
1000-1500 MHz 1
400-650 MHz 2
650-1000 MHz 3
250-400 MHz 4
R1 10K
R2 10K
R3 10K
R4 10K
1N4151
CR21
CR22
CR23
CR24
U7 MPQ3904
RN1 12K
+17V
-6.5V
R20 100
R21 100
R22 100
R23 100
1000-1500 MHz TO A23A1J5 (SHT 2)
400-650 MHz TO A23A1J4 (SHT 2)
650-1000 MHz TO A23A1J3 (SHT 2)
250-400 MHz TO A23A1J2 (SHT 2)
CR5 1N4830
C34 1.0
RN2 12K
U5 MPQ3906
ATTEN. 7 19
ATTEN. 6 20
ATTEN. 5 21
ATTEN. 4 22
R11 10K
R12 10K
R13 10K
R14 10K
A23A5 J4 (TO A22A12)
R44 100 1/2W
R45 100 1/2W
R46 100 1/2W
R47 100 1/2W
CR10 1N4151
CR11 1N4151
CR12 1N4151
CR13 1N4151
1 ATTEN 7
2 ATTEN. 6 30dB
3 ATTEN 5 30dB
4 ATTEN. 4 20dB
RN3 12K
U6 MPQ3906
ATTEN. 3 23
ATTEN. 2 24
ATTEN. 1 25
R15 10K
R16 10K
R17 10K
R48 100 1/2W
R49 100 1/2W
R50 100 1/2W
CR14 1N4151
CR15 1N4151
CR16 1N4151
5 ATTEN. 3 20dB
6 ATTEN. 2 20dB
7 ATTEN 1 10dB
A23A5 J1 (FROM A24-J1)
(+12V UNREG) 8,10
U11 LM317T
VIN VOUT ADJ
C31 1.0
C32 1.0
R51 150 1/8W, 1% 100ppm
R52 806 1/8W, 1% 100ppm
C36 10
A23A5 J3 (TO A22A13-J1)
9,11 (+6.7V)
1,3,5,8,12,14,16,18 20,22,24,25,26
2,4,6,12,14,16 17,18,20,22,24,26
19,21,23,25
N/C
10 -6.5V
1,3
L1 3.6µH
6,7
C40 22µF
C56 1µF
C18 .01
+6.5V
5,7
L2 3.6µH
-6.5V
C39 22µF
C57 1µF
C19 .01
13,15
L3 3.6µH
+17V
C58 22µF
C59 1µF
R33 120
R57 1.5K
C38 22
C70 .01
U8 MPQ6002
R39 1.0
+15V
9,11
L4 3.6µH
-17V
C60 22µF
C61 1µF
R34 120
R58 1.5K
C37 22
C21 .01
R40 5.6
-15V
A23A5 J4 (TO A22A12)
REVERSE POWER DETECTOR 9
C17 .01
R5 100K
CR4 1N963B
1/2 TL072
U10
CR1 1N4151
C1 1µF
+17V
R30 1K
R19 56K NOM.
-17V
C33 1.0
R29 470K
C3 1µF
R6 100K
R43 4.7K
Q5 2N4091
A23A5 J4 (TO A22A12)
R42 220
8 REV. POWER RELAY DRIVE
CR2 1N4151
CR3 1N4151
26 REV. POWER STAT.
A23A5 (TO A3J1) J2
REVERSE POWER CONTROL

NOTES: UNLESS OTHERWISE SPECIFIED
1) RESISTORS ARE IN OHMS, 1/4W 5%.
2) CAPACITORS ARE IN MICROFARADS.
3) CIRCUITRY IS PART OF A23-A5, 07792501, ASSY, PCB, OUTPUT MODULE CONTROL.

A23

Figure 5-64. Model 1501 Output Module Section 1 A23 Schematic (Sheet 1 of 2)


DETECTOR TIME CONSTANT SWITCHING
(TO A3-J1) J2
A23A5
DET TC2 16
.1-1MHz
DET TC1 17
1-10MHz
+15V
R91 2.7K 5%
U13
TL072
C4 1μF
C6 1μF
-15V
CR25 1N4830
R92 470 ¼W,5%
R93 470 ¼W,5%
L5 270μH
L6 270μH
CR17 1N4151
CR18 1N4151
CR19 1N4151
CR20 1N4151
C62 .047μF
C63 4700pF
C64 1μF
C65 1μF
U12
TL072
DETECTOR BUFFER
R64 4.99K
R65 4.99K
R66 10.0K
R67 10.0K
U14
½ NE5532
+REF (+10.00V)
R59 3.92K
1.22V
R60 442
.226V
R61 100 1%
CR26 1N4151
R62 68.1K
CR27 HP2800
CR28 HP2800
R97 10K
C66 10pF
R69 10.0K
R68 10.0K
C48 1μF
C49 1μF
DETECTOR LINEARIZER
R70 10.0K
R71 5K OFFSET
R72 18K, ¼W,5%
R73 10.0K
-REF (-10.00V)
R77 5K
GAIN
R78 12.4K
NOM.
R76 4.99K
C50 1μF
C51 1μF
U15
½ NE5532
A23A5 J5
DETECTOR OUT (TO A4 J4)
C47 .01
R89 61.9K
R90 61.9K
+ REF (+10.00V)
U9 AD581J
C52 1μF
R94 10.0K
R95 10.0K
- REF (-10.00V)
REF. VOLTAGE GENERATOR
+17V
R74 10 5%
R75 330 5%
Q6 2N3904
C46 10
FROM R20 (SHT 1)
FROM R22 (SHT 1)
FROM R21 (SHT 1)
FROM R23 (SHT 1)
J2 J4 J3 J5
250-400MHz
400-650MHz
650-1000MHz
1000-1500MHz
400MHz LPF
650MHz LPF
1000MHz LPF
1500MHz LPF
A23A1
250-1500 MHz FROM A22-J1 J1
J11
(.1-250 MHz) FROM A6-J3
J9
J10 J3
J6 J1
A23A3
J4 J1
J7 FROM R54 (SHT 1)
J5 FROM R53 (SHT 1)
J3 J4
A23A4
J2
.1- 1499.999999 MHz TO ATTENUATOR A22

NOTES:
1) RESISTORS ON THIS SHEET ARE 1%, MF EXCEPT WHERE INDICATED.
2) UNLESS OTHERWISE INDICATED, ALL CIRCUITRY IS PART OF A23A5, 07792501, ASSY, PCB, OUTPUT MODULE CONTROL.

Figure 5-64. Model 1501 Output Module Section 1 A23 Schematic (Sheet 2 of 2)

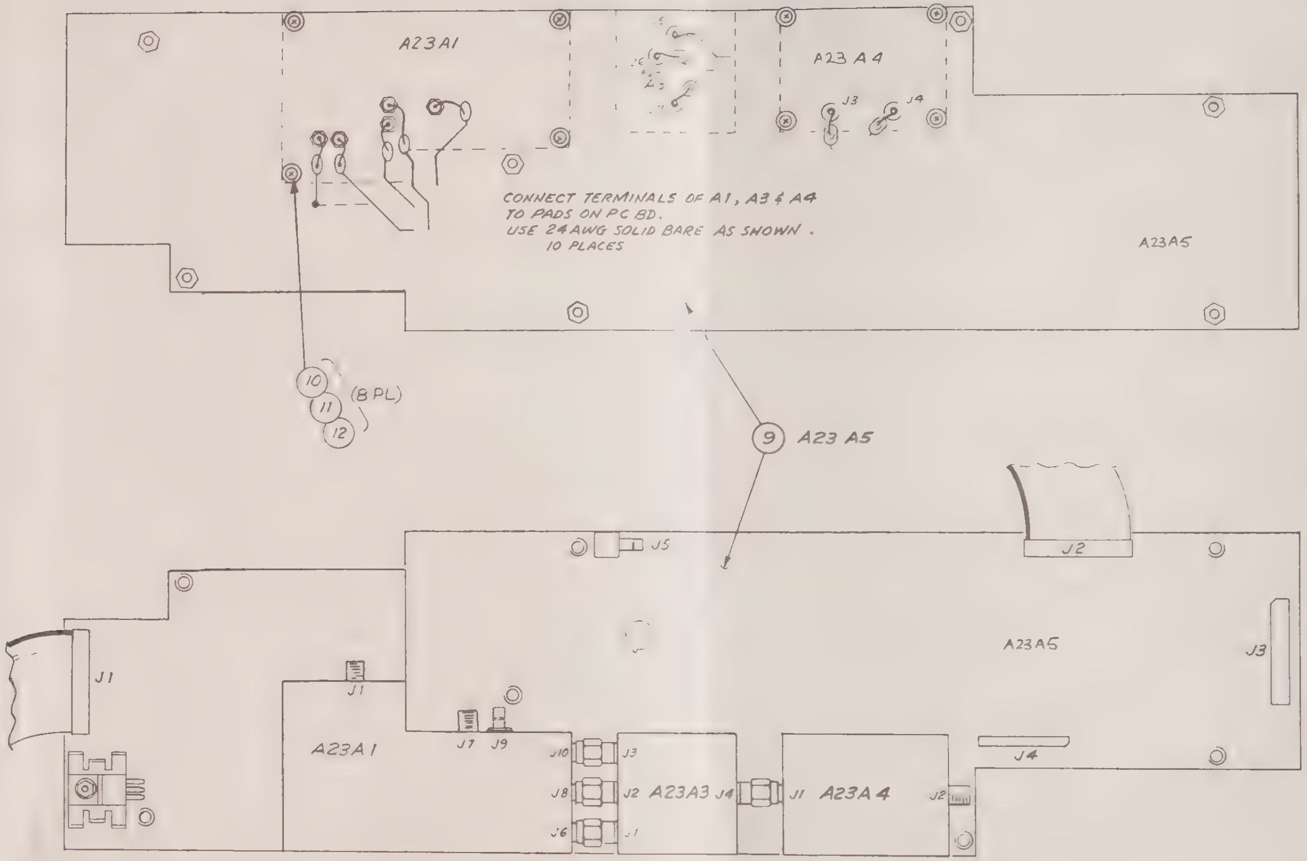
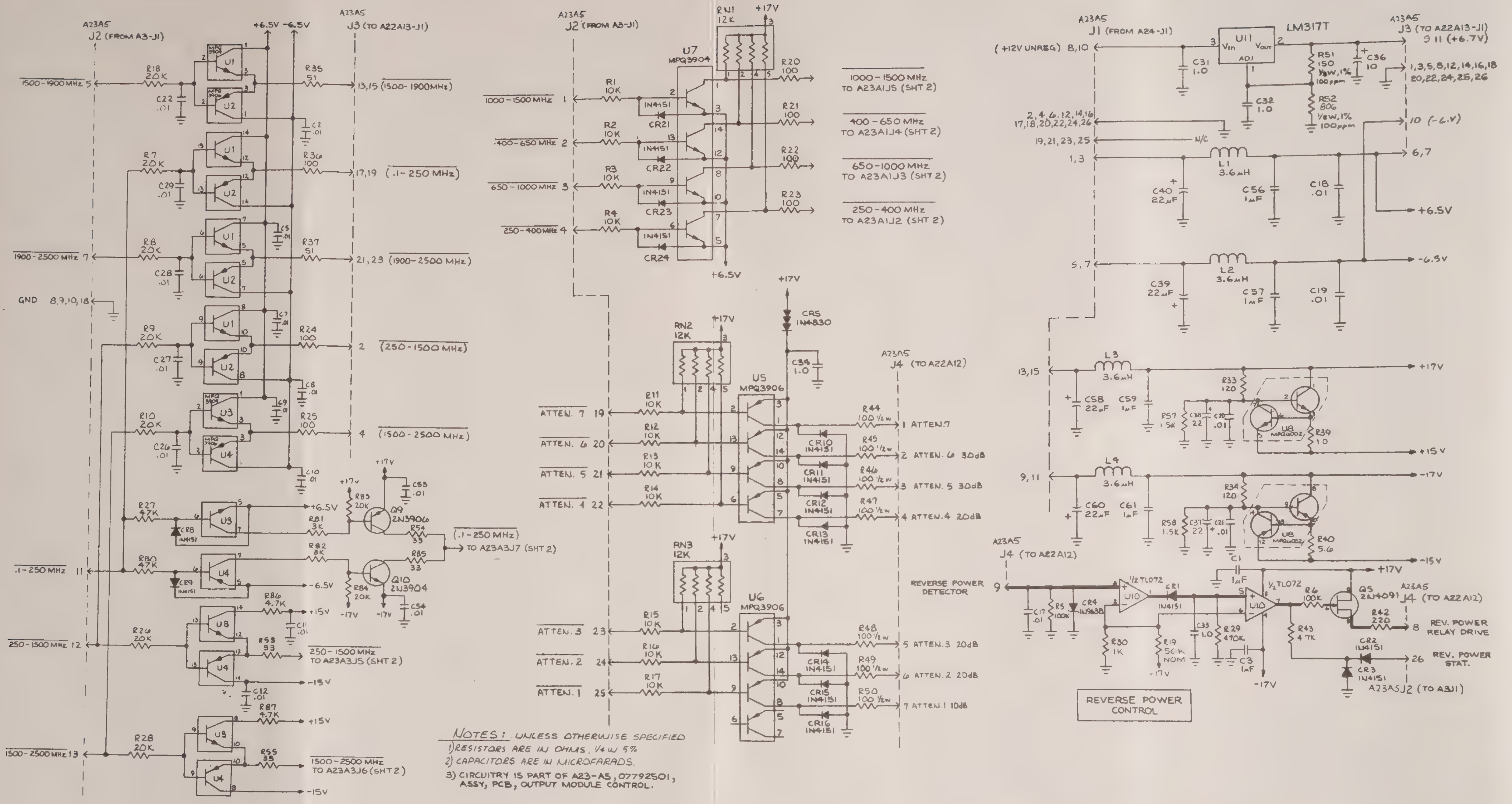

A23A1
A23 A 4
J3
J4
CONNECT TERMINALS OF A1, A3 & A4
TO PADS ON PC BD.
USE 24 AWG SOLID BARE AS SHOWN.
10 PLACES
A23A5
10
11
12
(8 PL)
9
A23 A5
J5
J2
A23A5
J3
J1
J1
A23A1
J7
J9
J10
J8
J6
J3
J2
J1
A23A3
J4
J1
A23A 4
J2
J4

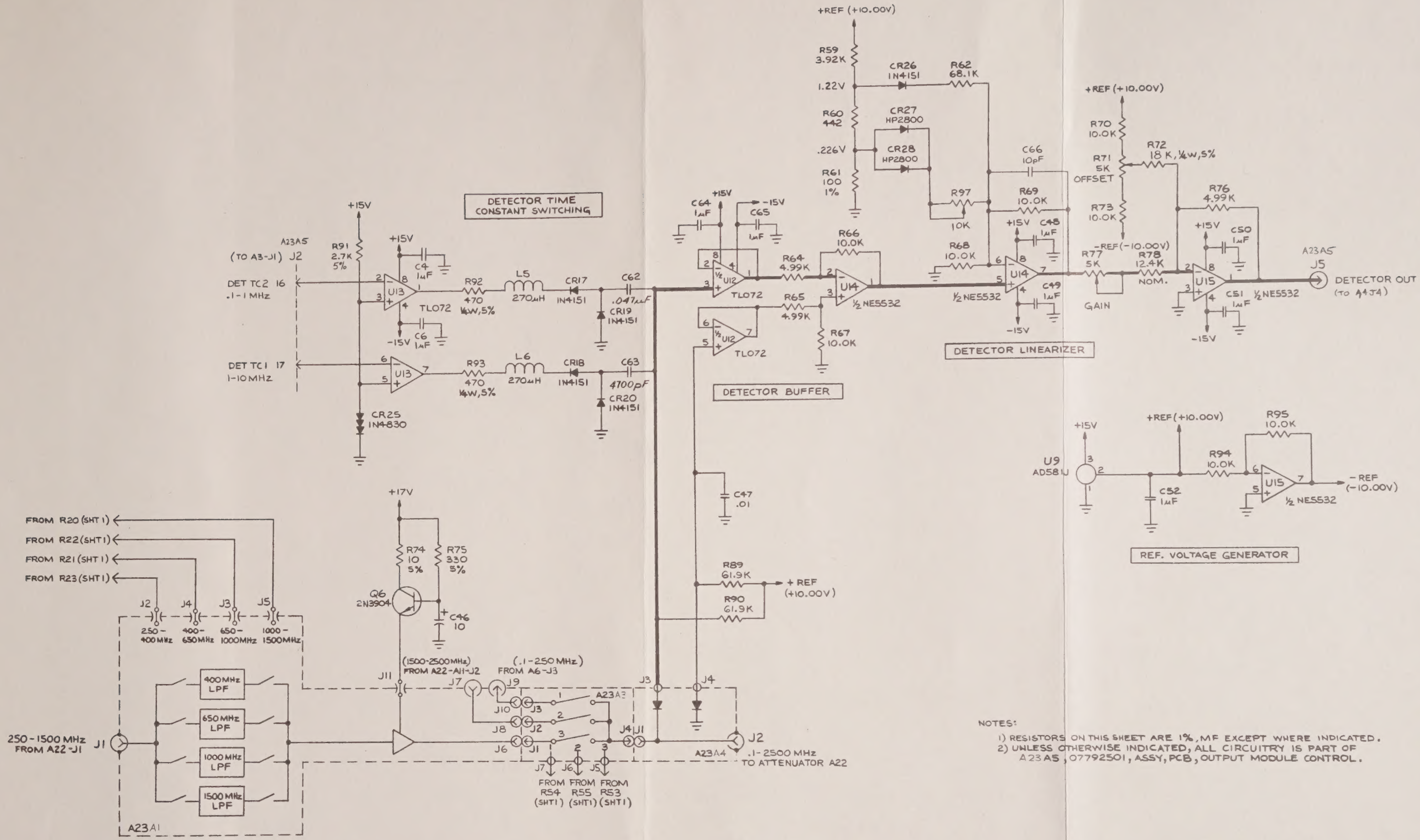
Figure 5-65. Model 1502 Output Module Section 1 Assembly A23


A23A5 J2 (FROM A3-J1)
+6.5V -6.5V
A23A5 J3 (TO A22A13-J1)
1500-1900 MHz 5
R18 20K
C22 .01
R35 51
13,15 (1500-1900MHz)
C2 .01
R7 20K
C29 .01
R36 100
17,19 (.1-250 MHz)
1900-2500 MHz 7
R8 20K
C28 .01
C5 .01
R37 51
21,23 (1900-2500 MHz)
GND 8,9,10,18
R9 20K
C27 .01
C7 .01
R24 100
2 (250-1500 MHz)
C8 .01
R10 20K
C26 .01
C9 .01
R25 100
4 (1500-2500 MHz)
C10 .01
U1 U2 U3 U4
MPQ3906
R27 47K
CR8 1N4151
+6.5V
R83 20K
R81 3K
Q9 2N3906
R54 33
C53 .01
+17V
(.1-250 MHz) TO A23A3J7 (SHT 2)
.1-250 MHz 11
R80 47K
CR9 1N4151
R82 3K
-6.5V
R84 20K
Q10 2N3904
R85 33
C54 .01
-17V
R86 4.7K
+15V
U8
C11 .01
250-1500 MHz 12
R26 20K
R53 33
250-1500 MHz TO A23A3J5 (SHT 2)
-15V
C12 .01
R87 4.7K
+15V
1500-2500 MHz 13
R28 20K
U3
R55 33
1500-2500 MHz TO A23A3J6 (SHT 2)
-15V
A23A5 J2 (FROM A3-J1)
RN1 12K
+17V
U7 MPQ3904
1000-1500 MHz 1
R1 10K
1N4151 CR21
R20 100
1000-1500 MHz TO A23A1J5 (SHT 2)
400-650 MHz 2
R2 10K
1N4151 CR22
R21 100
400-650 MHz TO A23A1J4 (SHT 2)
650-1000 MHz 3
R3 10K
1N4151 CR23
R22 100
650-1000 MHz TO A23A1J3 (SHT 2)
250-400 MHz 4
R4 10K
1N4151 CR24
R23 100
250-400 MHz TO A23A1J2 (SHT 2)
+6.5V
+17V
CR5 1N4830
C34 1.0
RN2 12K
+17V
U5 MPQ3906
A23A5 J4 (TO A22A12)
ATTEN. 7 19
R11 10K
R44 100 1/2W
1 ATTEN.7
ATTEN. 6 20
R12 10K
CR10 1N4151
R45 100 1/2W
2 ATTEN. 6 30dB
ATTEN. 5 21
R13 10K
CR11 1N4151
R46 100 1/2W
3 ATTEN. 5 30dB
ATTEN. 4 22
R14 10K
CR12 1N4151
R47 100 1/2W
4 ATTEN. 4 20dB
CR13 1N4151
RN3 12K
+17V
U6 MPQ3906
ATTEN. 3 23
R15 10K
R48 100 1/2W
5 ATTEN. 3 20dB
ATTEN. 2 24
R16 10K
CR14 1N4151
R49 100 1/2W
6 ATTEN. 2 20dB
ATTEN. 1 25
R17 10K
CR15 1N4151
R50 100 1/2W
7 ATTEN. 1 10dB
CR16 1N4151
A23A5 J1 (FROM A24-J1)
(+12V UNREG) 8,10
C31 1.0
U11 LM317T
VIN VOUT ADJ
R51 150 1/8W, 1% 100ppm
C36 10
A23A5 J3 (TO A22A13-J1)
9 11 (+6.7V)
1,3,5,8,12,14,16,18 20,22,24,25,26
C32 1.0
R52 806 1/8W, 1% 100ppm
2,4,6,12,14,16 17,18,20,22,24,26
19,21,23,25
N/C
10 (-6.V)
1,3
L1 3.6µH
6,7
C40 22µF
C56 1µF
C18 .01
+6.5V
5,7
L2 3.6µH
-6.5V
C39 22µF
C57 1µF
C19 .01
13,15
L3 3.6µH
+17V
C58 22µF
C59 1µF
R33 120
R57 1.5K
C38 22
C20 .01
U8 MPQ6002
R39 1.0
+15V
9,11
L4 3.6µH
-17V
C60 22µF
C61 1µF
R34 120
R58 1.5K
C37 22
C21 .01
U8 MPQ6002
R40 5.6
-15V
A23A5 J4 (TO A22A12)
C1 1µF
+17V
REVERSE POWER DETECTOR 9
C17 .01
R5 100K
CR4 1N5938
1/2 TL072 U10
CR1 1N4151
R30 1K
R19 56K NOM
-17V
C33 1.0
R29 470K
C3 1µF
1/2 TL072 U10
-17V
R6 100K
Q5 2N4091
R43 4.7K
A23A5 J4 (TO A22A12)
R42 220
8 REV. POWER RELAY DRIVE
CR2 1N4151
CR3 1N4151
26 REV. POWER STAT.
A23A5J2 (TO A3J1)
REVERSE POWER CONTROL

NOTES: UNLESS OTHERWISE SPECIFIED

1) RESISTORS ARE IN OHMS, 1/4 W 5%
2) CAPACITORS ARE IN MICROFARADS.
3) CIRCUITRY IS PART OF A23-A5, 07792501, ASSY, PCB, OUTPUT MODULE CONTROL.

Figure 5-66. Model 1502 Output Module Section 1 A23 Schematic (Sheet 1 of 2)


+REF (+10.00V)
R59 3.92K
1.22V
CR26 1N4151
R62 68.1K
R60 442
CR27 HP2800
.226V
CR28 HP2800
R61 100 1%
R97 10K
C66 10pF
R69 10.0K
R68 10.0K
+REF (+10.00V)
R70 10.0K
R71 5K OFFSET
R72 18 K, ¼W,5%
R73 10.0K
R76 4.99K
-REF (-10.00V)
R77 5K GAIN
R78 12.4K NOM.
C48 1μF
C49 1μF
U14 ½ NE5532
DETECTOR LINEARIZER
+15V
-15V
C50 1μF
C51 1μF
U15 ½ NE5532
A23A5 J5
DETECTOR OUT (TO A4J4)
DETECTOR TIME CONSTANT SWITCHING
+15V
A23A5 (TO A3-J1) J2
R91 2.7K 5%
DET TC2 16 .1-1 MHz
DET TC1 17 1-10 MHz
C4 1μF
U13 TL072
C6 1μF
-15V
R92 470 ¼W,5%
L5 270μH
CR17 1N4151
C62 .047μF
CR19 1N4151
R93 470 ¼W,5%
L6 270μH
CR18 1N4151
C63 4700pF
CR20 1N4151
CR25 1N4830
C64 1μF
C65 1μF
+15V
-15V
½ U12 TL072
R64 4.99K
R65 4.99K
R66 10.0K
R67 10.0K
U14 ½ NE5532
DETECTOR BUFFER
C47 .01
R89 61.9K
R90 61.9K
+ REF (+10.00V)
+15V
+REF (+10.00V)
U9 AD581J
C52 1μF
R94 10.0K
R95 10.0K
U15 ½ NE5532
- REF (-10.00V)
REF. VOLTAGE GENERATOR
FROM R20 (SHT 1)
FROM R22 (SHT 1)
FROM R21 (SHT 1)
FROM R23 (SHT 1)
J2 J4 J3 J5
250-400MHz 400-650MHz 650-1000MHz 1000-1500MHz
400MHz LPF
650MHz LPF
1000MHz LPF
1500MHz LPF
A23A1
250-1500 MHz FROM A22-J1 J1
+17V
R74 10 5%
R75 330 5%
Q6 2N3904
C46 10
J11
(1500-2500MHz) FROM A22-A11-J2
(.1-250 MHz) FROM A6-J3
J7 J9 J10 J3 J8 J2 J6 J1
A23A3
J3 J4
J4 J1
A23A4 J2
.1-2500 MHz TO ATTENUATOR A22
J7 J6 J5
FROM RS4 (SHT1)
FROM R55 (SHT1)
FROM R53 (SHT1)

NOTES:

1) RESISTORS ON THIS SHEET ARE 1%, MF EXCEPT WHERE INDICATED.
2) UNLESS OTHERWISE INDICATED, ALL CIRCUITRY IS PART OF A23A5, 07792501, ASSY, PCB, OUTPUT MODULE CONTROL.

Figure 5-66. Model 1502 Output Module Section 1 A23 Schematic (Sheet 2 of 2)

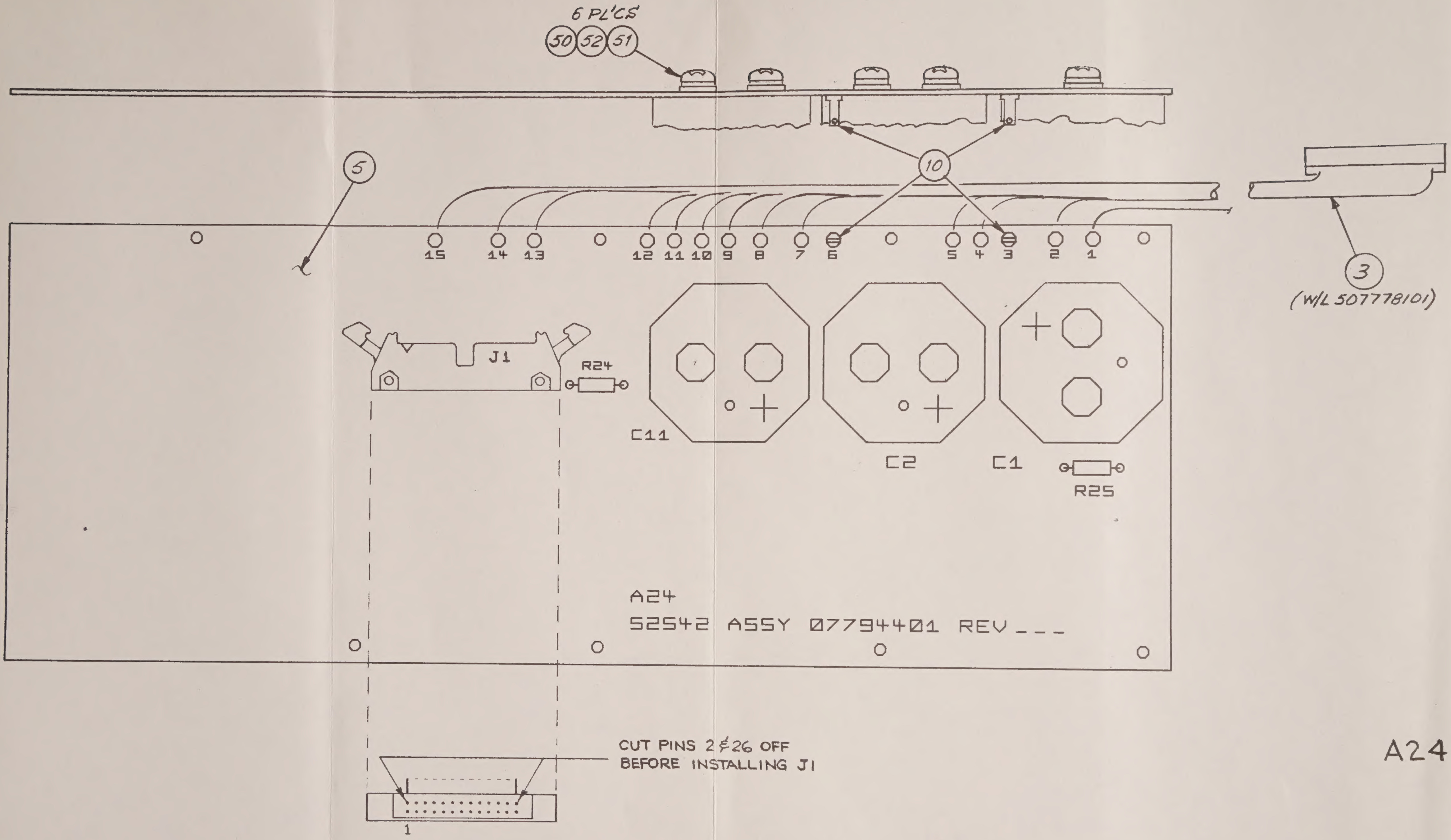

6 PL'CS
50
52
51
5
10
3
(W/L 507778101)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
J1
R24
C11
C2
C1
R25
A24
52542 ASSY 07794401 REV ___
CUT PINS 2 & 26 OFF
BEFORE INSTALLING J1
1
A24

Figure 5-67. Power Distribution PC Board Assembly A24